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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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FOR BOILERS OF ALL TYPES.
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See page 96, June 15. 5734

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See Advertisement page 63. 5701

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Three Sizes, Delivery from Stock.
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ALL BRITISH BUILT. 4309
Works:—MIDDLETON, BOGNOR, ENGLAND.
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Telegrams—"Soaring, Bognor." Telephones—Bognor 40.
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Yarrow Patent Water-tube Boilers. 4985
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Head, Wrightson & Co.,
LIMITED.
See Advertisement page 43, June 8. 3402

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LEVENFORD WORKS, **Dumbarton.** 6304
See Full Page Advt. page 80, June 1.

Forgings.
Walter Somers & Co., Ltd.,
HALESOWEN. 5549

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5196

Railway Switches and Crossings.
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See Advertisement page 58, June 8.

Improved High Pressure
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See our Advertisement in last week's issue, page 96.
BRITISH STEAM SPECIALITIES, LTD.,
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Aluminium.
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Destroyers, Torpedo Boats, Yachts and Fast Boats. Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND. 5466
See half-page Advertisement page 73, June 15.

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

Chief Engineer: C. E. STROMEYER, M.I.C.E.

Founded 1854 by Sir W. FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 8654

THE MANCHESTER MUNICIPAL School of Technology (UNIVERSITY OF MANCHESTER.)

PRINCIPAL: J. C. M. GARNETT, M.A. (late Fellow of Trinity College, Cambridge).

The SESSION 1917-18 will open on 8th OCTOBER. Matriculation and Entrance Examinations will be held in July and September.

The Prospectus, forwarded free on application, gives particulars of the courses leading to the Manchester University degrees in the Faculty of Technology, and of the provision for Advanced Study and Research in the following departments:—

MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING,
SANITARY ENGINEERING (including Municipal Engineering),
THE CHEMICAL INDUSTRIES (including General Chemical Technology, Bleaching, Dyeing and Dyestuff Manufacture, Printing, Papermaking, Brewing and Metallurgy),
THE TEXTILE INDUSTRIES,
PRINTING AND PHOTOGRAPHIC TECHNOLOGY,
MINING,
ARCHITECTURE.

Intending students may enrol for the Session 1917-18 from 1st August, 1917. Members of the University under 18 years of age are eligible for membership of the Officers' Training Corps. H 1

TENDERS.

COUNTY BOROUGH OF SALFORD.
ELECTRICITY DEPARTMENT.

Tenders Required by Noon

on Monday, June 25th, 1917, for the SUPPLY and ERECTION of STEAM BOILER HOUSING, comprised of Steel Framework and Corrugated Sheeting.—Particulars from the BOROUGH ELECTRICAL ENGINEER, Frederick Road, Salford. G 966

LONDON COUNTY COUNCIL.

The Council invites

Tenders for the Removal and

DISPOSAL of ASHES from its Generating Station at East Greenwich, during the twelve calendar months commencing 1st August, 1917.

Particulars and Forms of Tender may be obtained at the Tramways Office, 62, Finsbury Pavement, E.C. 2.

No Tender will be considered if received at the County Hall, Spring Gardens, S.W. 1, after Four p.m. on Monday, 2nd July, 1917. The Council does not bind itself to accept any Tender.

JAMES BIRD, H 59
Clerk of the London County Council.

Offers are Invited for a Marine

(Bolander) OIL ENGINE of 120 HP. as now lying at Lowestoft; suitable for coasting vessel or fishing craft; complete with fuel tanks, silencer, starting air bottle, &c., and all usual fittings, but without propeller and propeller shaft. Intending purchasers should arrange to inspect, for which purpose an inspection order is necessary.—Applications for this and Offers for the Engine should be made promptly to Mr. JOSEPH LOWERY, Secretary, Salvage Association, 19, Birchin Lane, London, E.C. 3. H 51

IN THE MATTER OF THE TRADING WITH THE ENEMY AMENDMENT ACT, 1916.

The PUBLIC TRUSTEE invites

Tenders for the Purchase of

the Whole or any part of 119,980 Shares of £5 each, fully paid, in SIEMENS BROTHERS & COMPANY, LIMITED, vested in him as Custodian by an Order made by the Board of Trade, in pursuance of Section 4 of the Trading with the Enemy Amendment Act, 1916, and dated 9th August, 1916.

The issued capital of the Company consists of 120,000 Shares of £5 each, fully paid.

The purchasers, who must be British-born subjects, will be required to make a sworn Declaration as to nationality and freedom from foreign control on a form to be obtained from the Offices of the Public Trustee.

The purchasers will also be required to satisfy the Public Trustee as to their financial and technical ability to carry on the business of the Company as efficiently as heretofore, or otherwise to the satisfaction of the Government.

A report upon the Company's operations and affairs has been prepared by the Company, in conjunction with the Company's Auditors (Messrs. PRICE, WATERHOUSE & Co.), and with Messrs. TURQUAND, YOUNGS & Co. Copies of this report can be obtained, subject as hereinafter mentioned, together with copies of Company's accounts up to the 31st December, 1915, on written application to the Public Trustee, Kingsway, W.C.

All applicants will be required to satisfy the Public Trustee as to any matter which he may think fit to investigate before copies of such Report or accounts will be supplied.

Intending Tenderers who desire to inspect the property of the Company, should apply to the Public Trustee for an authority to do so.

Tenders must be delivered, sealed, to the Public Trustee, Kingsway, W.C., on or before Thursday, the 12th July, 1917 (NOT 14TH JUNE, AS PREVIOUSLY ADVERTISED), at Twelve o'clock Noon, and marked on the envelope, "Tender, Siemens Shares."

The Public Trustee does not bind himself to accept any Tender, and reserves to himself all rights in connection therewith.

Forms of Tender can be obtained from the PUBLIC TRUSTEE.

Dated this 8th day of February, 1917. 8642
C. J. STEWART, Public Trustee,
Custodian for England and Wales.

THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of

the following STORES, namely:—
SPARE PARTS for Carriages and Wagons.
Acid Open-hearth STEEL BOILER PLATES.
COPPER RODS.
COPPER TUBES.

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Spare Parts for Carriages and Wagons," or as the case may be, not later than Eleven o'clock a.m., on Thursday, the 28th June, 1917.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall Avenue, E.C., London,
20th June, 1917. H 82

APPOINTMENTS OPEN.

Metallurgists and

METALLURGICAL CHEMISTS (temporary) REQUIRED.

Commencing salary £260 per annum.

Applications, giving full particulars of qualifications and experience to be forwarded to the

SUPERINTENDENT OF RESEARCH,
Royal Arsenal,
Woolwich.

H 87

COVENTRY MUNICIPAL TECHNICAL INSTITUTE.

Wanted, in September next,

an ASSISTANT ENGINEERING MASTER, ineligible for military service.

Forms of application, which may be obtained on receipt of a stamped addressed foolscap envelope from the undersigned, must be returned, duly completed, with a statement of amount of salary required, or or before Monday, 16th July, 1917.

FRNDK. HORNE,
Secretary.

Education Offices,
Council House, Coventry.
19th June, 1917. H 63

First-class Experienced

ESTIMATOR WANTED by Government controlled works making large and small engines, repetition and general work; man with thorough practical knowledge of machining, fitting and foundries, &c., who could organise and control a department dealing with rate-fixing, progress and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience and salary required. No one already employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 20.

Wanted, at Once, the Services

of a fully experienced Naval ARCHITECT who can offer either his whole or spare time for work in London office.—Apply by letter, stating age, experience, amount of time at disposal, and salary required, to H 86, Offices of ENGINEERING.

Assistant Locomotive

SUPERINTENDENT REQUIRED for the Uganda Railway. Salary £350-£30-£350 per annum. Free first-class passages and quarters. Candidates must have had a thorough training in locomotive workshops and offices, and possess a sound knowledge of footplate and general running work and some experience of management and supervision of staff.—Apply, by letter, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1. Men engaged on Government work or eligible for military service will not be considered. H 47

Wanted, by a Leading Boiler

Insurance Company, additional BOILER INSPECTORS. Applicants must be practical engineers with a good technical training, capable of making accurately dimensioned sketches of all classes of steam boilers and of writing clear reports on condition. Commencing salary £12 10s. per month, plus war bonus. Applicants must be over military age, but not exceeding 45 years.—Address, H 38, Offices of ENGINEERING.

Wanted, in London Suburb,

Experienced Engineering WORKS' ACCOUNTANT; must be used to analysis, bonus, stores—accountancy, and financial statements. Apply, stating experience and salary. Must be exempt from military service. Address, H 37, Offices of ENGINEERING.

Wanted, for General En-

gineering Works near London, an experienced WORKS PROGRESS CLERK, with full knowledge of up-to-date methods. No person engaged on Government work will be employed. — Apply, stating age, experience, salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this paper and No. A 3396. H 96

Required, Manager for Steel

Foundry in South of England. Must have good knowledge of chemistry, and be thoroughly conversant with latest foundry practice. Liberal salary to first-class man.—Write BOX 8462, care of A. J. WILSON & Co., LTD., 134, Clerkenwell Road, London, E.C. 2. G 766

Mechanical Engineer for

RUSSIA. — WANTED, highly qualified MAN, to Organise Technical Department of large importing house acting as agents and merchants for leading British manufacturers of Industrial Machinery, Prime Movers, &c. Must have previous Russian experience. Attractive terms will be offered for thoroughly competent man with good connection.—Apply, by letter, stating age, salary and qualifications, to S. Q., care of STREET'S, 30, Cornhill, E.C. 3. H 9

Wanted, an Engineer with

first-class theoretical education, to take tests and records of boilers, engines, transmission gear and electric plant in large works near London. Permanent position with good prospects to the right man. State age, salary and particulars of experience.—Address, H 6, Offices of ENGINEERING.

Chief Engineer Wanted in

medium size Brewery.—Apply, by letter, to W. BUTLER & CO., LTD., Springfield Brewery, Wolverhampton. H 77

Assistant Engineer is

REQUIRED by a large Firm of Iron Masters and Colliery Owners in the Midlands. Must be six o'clock man, keen, energetic, and capable of carrying out general maintenance work quickly and economically. In reply give full particulars of previous experience, age, when at liberty and salary expected.—Address, H 56, Offices of ENGINEERING.

Assistant Engineer Required

Immediately for a controlled establishment in South West of England, exclusively employed on Government work. Must have sound theoretical and practical training, and should preferably have been engaged upon aeroplane or seaplane construction. Capable organiser, with good experience of repetition work. No person already on Government work will be engaged.—State age, full particulars of past experience and salary required to your nearest EMPLOYMENT EXCHANGE, mentioning Box number A 3315. H 49

Dredging.—Assistant Engin-

EER WANTED, capable of setting out, measuring up and assisting in supervision of dredging work. — Address, H 75, Offices of ENGINEERING.

Civil Engineering

DRAUGHTSMAN WANTED (Junior). Some knowledge of ferro-concrete and steel work desirable.

Must be ineligible for military service.

Write, stating age, full particulars and salary required, to SUPERINTENDING CIVIL ENGINEER, H.M. Naval Depot, Dover. H 93

Draughtsmen Wanted

for London; must have had works experience; accustomed to light structural steel, engine or heavy motor traction work. Write in first instance, stating age, salary expected, and briefly qualifications, experience and position regarding military service.—Address, MINISTRY OF MUNITIONS, 17, Cockspur Street, S.W. 1, and mark envelope "Section 1B." H 3

Chief Draughtsman.—Wanted

by controlled establishment in Midlands, CHIEF DRAUGHTSMAN with experience in gas producer plants and gas fired furnaces; excellent opening for capable man. No one already employed on Government work will be engaged. State experience fully and salary required. — Apply, nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 974.

Jig and Tool Draughtsman

REQUIRED for Aviation Works near London. Good man required. No person resident more than 10 miles away or already engaged on Government work need apply. State age, salary and experience. —Write, BOX 747, SAMSON CLARK & Co., LTD., 56, Gt. Portland St. W. 1. H 4

Wanted, Draughtsman for

the mechanical design of large electrical direct current machines. Nobody engaged on Government work will be accepted.—Write or apply to the nearest Board of Trade EMPLOYMENT EXCHANGE, mentioning the Journal and No. A 2631. G 457

Wanted Immediately, in the

Midlands, a DRAUGHTSMAN accustomed to blast furnace upkeep and repairs. No one already employed on Government work will be engaged. — Reply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 27.

Wanted, First-class Mechani-

CAL DRAUGHTSMAN. One experienced in steel furnace construction preferred.—Apply, your nearest EMPLOYMENT EXCHANGE, stating experience, and salary required, mentioning this Journal and G 993. Men on Government work need not apply.

Draughtsman Wanted, for

large mill near London, must be accustomed to power production and transmission. Applicants must be ineligible for military service. State age, salary and particulars of experience.—Address, H 59, Offices of ENGINEERING.

Draughtsman Wanted, thor-

oughly capable, for large blast furnace and steel works plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 3295. G 986

Draughtsman, Junior

MECHANICAL, WANTED, by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application in the first instance should be made to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3284. G 849

Draughtsman Required for

Chief Engineer's Drawing Office in large rolling mills in Midlands. State age, experience, and salary required. No one already employed on Government work will be engaged. Application in the first instance should be made to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 30.

Draughtsmen.—Several

Juniors WANTED quickly for Government work in Midland Engineering Works. Permanent jobs for suitable men.—Apply, stating age, experience fully, salary expected, and when at liberty, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3306. No person already on Government work will be engaged. H 44

Wanted, Thoroughly Capable

DRAUGHTSMAN for Engineering Office in London. No one already employed on Government work will be engaged.—Apply your nearest LABOUR EXCHANGE, mentioning this Journal and H 74.

Lady Tracer Wanted at Once;

must have first-class experience and references.—Address, stating salary required, H 65, Offices of ENGINEERING.

Foreman Engineer Wanted,

in Clyde district, to take charge of machines. Must be accustomed to high-class fast work in forged steel upon medium heavy machine tools. State in confidence, full particulars of experience and wages expected. No one already on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3312. H 72

Wanted, Foreman over 50

Machines and Lathes, large and medium; capable of getting maximum output. State age, present and previous employers, and wages. No man on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 685

A Large Firm of Engineers,

in the Midlands, have an OPENING for a YOUTH of good education as premium pupil, the course to include both works and drawing office.—Address, 4260, Offices of ENGINEERING.

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SUPERINTENDENT, Assoc. M.I.C.E., M.I.Mech.E. Wide experience in general engineering and modern shop practice, combined with a sound knowledge in the manufacture of War material, shell filling. Inspection examination, all natures. Aeroplane building. Accustomed to handle, direct and control large bodies of men and women. Day and piece work. Available at once.—Address, H 71, Offices of ENGINEERING.

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all-round experience in Harbour and River Works at home and abroad, and with constructional experience of Water Supply and Railway Works, is OPEN to CONSIDER OFFERS of Employment. Eight years present situation.—Address, H 13, Offices of ENGINEERING.

Works Manager, M.I.Mech.E.,

&c., DESIRES CHANGE. Wide experience on all classes of War Material and General Engineering; good disciplinarian; very energetic, and used to controlling large numbers of men.—Address, H 19, Offices of ENGINEERING.

Metallurgist and Steel Mana-

GER, with 15 years' practical experience in all branches of Steel Manufacture, and sound theoretical training, is OPEN for ENGAGEMENT with progressive firm. Excellent testimonials. Would consider partnership.—Address, Z.G. 554, care of DRACON'S 7, Leadenhall Street, London, E.C. 3. H 96

To Contractors.—Applicant

DESIRES POSITION as Steam Foreman. Well up in the running and repairs of locos, cranes, portables, pumps, motors, &c.; age 50; home or abroad; good references.—Address, H 35, Offices of ENGINEERING.

Manager. — Highly Experi-

enced Works Manager, ineligible, 20 years' experience in high-class engineering work, is OPEN to TAKE POSITION of responsibility.—Address, H 36, Offices of ENGINEERING.

Civil Engineer, Graduate,

SEEKS POSITION; office and works experience, steel bridge and roof work, reinforced concrete and general civil engineering.—Address, H 45, Offices of ENGINEERING.

Bridges, Buildings, Drainage,

Systems. A Civil Engineer, with 14 years' practical experience on works, DESIRES ENGAGEMENT as Resident Engineer, or with Contractor on works of national importance. Excellent references.—Address, giving full particulars, H 42, Offices of ENGINEERING.

Works Commercial and

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WORKSHOP TRAINING OF APPRENTICES IN THE LIGHT OF RECENT DEVELOPMENTS.

By NEIL J. MACLEAN.

AMONG the many problems connected with the engineering industry upon which experience gained during the war has shed fresh light, is that of the workshop training of apprentices, and with a view to promoting a clearer understanding of its different aspects I set forth my views below in a series of axioms, supported by some notes on the application of these axioms to a system of apprentice training, as worked out in detail in the factory with which I am connected. The more advanced training, which should include a university engineering course, is not dealt with, as this must necessarily be planned on different lines throughout; only the regular workshop training which will enable a man to qualify as a skilled workman, a draughtsman, or a junior shop executive—foreman, under-foreman, inspector, &c.—is under consideration.

It will make a good starting-point, in trying to sort out one's thoughts on this subject, to remember that the raw material in question, when we begin work with him, is the boy, a wayward, unstable, light-hearted, elder child, a dreamer of dreams, eager, easily interested and easily tired; that during his period of training he passes through the critical point of development from boy to man, at about the age of eighteen; that we are dealing with man in his seedtime, and, hence, largely according to our sowing so shall the reaping be; and that the habits that are formed during this period will have a determining influence on the character developed during later years.

Among the habits that will most surely promote his success later on is the habit of industry, of steady, constant and intelligent labour, and this brings me to the statement of my first axiom: *The apprentice must be always busy.* It sounds simple and looks obvious, but in practice it is a condition neither easy to bring about nor to maintain. To begin with, the boy altogether lacks skill and must be shown how to do his work; this occupies the time and attention of a trained man; work suitable to his inexperience must be found for him; his interest in this work, easily roused, is easily tired, while his ingenuity—when tired of the job—in escaping from control is ever alert and watchful of its opportunity. And yet if, during his training, there are frequent spells of idle time, the habit of industry has but a poor chance to form itself, and if not formed then, permanent harm to the boy's character must surely result.

The requirements of industry are growing more exacting, more complex; there is more ground to cover before one can be considered trained, even in a single department of the many trades comprehended within the term "engineering"; for the apprentice there is, therefore, much to learn, a wide country to explore. This brings me to my second axiom: *The apprentice must be always learning.* He must be taught to do a certain thing properly and must then be moved on to a different kind of work. The thing he is given to do first must be easier to learn than what follows. In this way confidence in his ability to perform specified tasks will gradually be acquired, whilst the range of the different kinds of work with which he is intimately familiar will be steadily widened. At the same time, by ensuring a sufficient variety in the work, attention and interest are maintained; for it must be repeated with insistence, a boy's interest is easily tired, and if lost, mischief is an inevitable result.

The engineer of a century ago was an empiricist, a cut-and-try man. He depended almost entirely on his previous practical experience; he worked to sketches, simple drawings, or models. If his first attempt to get a certain result did not succeed, he felt his way forward gropingly by practical experiments to a more successful conclusion. It is different to-day. Now he must appreciate exactness in size; he must easily read complicated drawings; he must be able to think in three dimensions, and have some knowledge of physics and chemistry; which brings me to my third axiom: *Engineering is an exact science, and the apprentice must develop the scientific mind.*

I use the term "engineer" in its broadest sense throughout, not limiting it to the director of great enterprises, the executive in charge of factories, or the workman actually carrying out a given task. Of course the training given to a group of boys in any workshop will vary individually to suit their prospective positions, but the fundamental principles are common to all, and if these are not understood and observed, successful results cannot be expected.

During apprenticeship the schoolboy of from fifteen to seventeen years of age must be turned into a young man able to think exactly, to observe accurately, and to note down clearly his results. He must develop the quantitative sense, the ability to appreciate instantly and without conscious effort the magnitude of the quantities he is at the moment dealing with. To obtain such a result the training must involve an intimate mingling of practical and theoretical work, of shop experience and study, of things seen and done, things noted and written down.

Now, it must never be lost sight of that since an apprentice is trained in a workshop or factory whose business it is to make things for sale, he is hedged round with commercial conditions and considerations which may conflict with the requirements of his training. A nice balance must be struck between interests which will not always or obviously work together for a common end; and long views of what will ultimately benefit the firm, or the trade, or the nation, must be considered along with the more immediate needs of factory output and organisation; in view of which we arrive at my fourth axiom: *The apprentice's course of training must not be determined by the shop foreman or manager responsible for output.* If it is, then considerations of output will weigh too heavily and the apprentice will not get the variety of experience which is essential to fulfil axioms (2) and (3). A member of the firm having authority must determine the course of training of each apprentice in detail and must ruthlessly override any objection to necessary changes advanced by department foremen on the grounds of interference with output. This condition is the more imperative as industry becomes specialised and departments more highly organised, so that variety of experience within any one department is more and more curtailed.

We have heard and read much recently of the ca' canny policy, of its mistaken basis and its harmful results. It is chiefly founded upon the idea that there is not enough work to go round. The trade unionist knows that fellow-members are out of work; therefore, says he, "I will do a little less and some of them will get a job." But this line of reasoning is not confined to the trade unionist; it crops up in other forms among other classes. The educated man says to himself, if too many highly educated men are turned out, there won't be enough comfortable berths for us all. Ergo, says he, put the brake on the education wheel; avast there, turning out too many B.Sc.'s. I think I have even read leading articles in the engineering journals voicing this view in more polished phrases. Now, the principle on which this conclusion is based has been thrown on the scrap heap. Let us make sure that the different conclusions themselves find their way to the same well-merited destination; which leads me to my fifth axiom: *There cannot be too many highly trained apprentices.*

There must always be forces at work that will keep back some of the starters from being finishers; ill-health, family trouble interfering with apprenticeship, decay of ambition, these will interfere with the successful completion of training courses in many cases. Against these, employers must always pit all the forces and influences at their command to turn out as many highly trained, highly educated apprentices as they possibly can, confident that the supply cannot outrun the demand. The more that are turned out, the more useful energy and creative force has been added to the nation's stock.

The industrial lesson of the past two years that has bitten most deeply into thoughtful minds, I think, is this—that, given good executive direction, high-class work can be turned out by comparatively untrained labour. But the executives must be good, very good. Now, the training that is required by a good engineering executive is so elaborate, thorough and comprehensive, that it cannot begin too early, or be too carefully planned and directed; which enables me to state my sixth and last axiom: *Special training must be given to those apprentices who show marked ability.*

A reasonable time after starting work must elapse before selection is possible; then some form of thorough test should be applied to divide the apprentices into those who can be expected only to turn into competent workers and those who may one day take the lead and rise to responsible positions. Opportunities of specially varied training and of higher study in connection with it can then be provided for the selected boys, with confidence that such facilities will not be wasted.

Having examined some of the fundamental principles that must underlie any system of training for apprentices to the mechanical trades and reduced these to simple axiomatic form, it may be of interest if their working out, as applied to a particular factory, is described in some detail. Such a system of apprenticeship has been under trial in the works of Barr and Stroud, Limited, Glasgow, for the past 12 years, a period long enough to enable an opinion to be formed of its results. A large number of apprentices have graduated under it and have proved themselves able to do good work in other factories in this country and abroad, while the junior executive positions throughout the factory are now in many cases filled by men trained under the system.

At the present time over 300 apprentices are employed, engaged in all branches of the fine mechanical trades, fitting, machining, tool-making, electrical engineering, pattern-making, moulding, joiner-work, instrument-making, and optical prism polishing. Apprenticeship is for five years, commencing at fifteen or sixteen years of age. The boys are not indentured, but they are expected to spend the full training period with the firm. No boys not apprenticed are employed.

Considering the axioms in order, the first—that an apprentice must always be busy—is not easily reduced to any definite rules; it depends largely on the general atmosphere throughout the shops. The practice is closely followed that at each stage of training a boy is under the supervision of a man expert in his own branch of the trade, whose duty it is definitely to show the boy how to do the work, and also to see that he is kept constantly employed. Where difficulty is met with in developing in a boy a habit of steady work, special steps to overcome it are taken. He is put on to work in which the day's task can be very exactly measured and his performance closely watched. This is not done only in a disciplinary spirit, as it must be clearly recognised that if a worker in the mechanical trades fails to acquire habits of regular industry, he can never earn any useful place for himself in organised industrial work.

The second axiom—that an apprentice must always be learning—is applied by arranging in sequence a series of different kinds of operations which he successively undertakes, commencing with the simplest. A change of work is arranged for about once every six months. During the first half of apprenticeship the training for most of the trades follows the same general lines, including fitting and machining; during the second half of the training each apprentice specialises in his own particular craft. Pattern-makers spend some months in the foundry, opticians some months in the machine shop, and so on. A special feature is made of the fourth-year training for instrument-makers, which is carried on under a qualified instructor, the work consisting as far as possible of the building of complete instruments of odd types.

The fourth year of any system of training is, I think, the critical period. It coincides with that difficult age when a boy is unsettled, whimsical, discontented, groping about uncertainly in search of the larger powers and responsibilities of manhood. It often happens, too, to be the time at home when the difficulty which his parents find in supporting him at a comparatively low wage presses hardest; he is still earning little and the end of his training period seems a long way off. His early interest in the work may have flagged, while he is still not

master enough of his trade to find pleasure in working at it. For these reasons I think the fourth-year apprentice should receive particular attention. Care should be taken to make the work as interesting as possible, to appeal to his growing sense of craftsmanship by varied and carefully selected work, to see that he works under a wise and competent guide who will watch for signs of insubordination and deal with these in a proper and understanding spirit.

The third axiom—that engineering is an exact science—is applied by bringing all possible pressure to bear on the boys to attend regularly suitable technical classes in the evenings. As the day's work does not begin till eight o'clock there is less objection—if, indeed, there is any at all—to the boys being expected to study at night than in cases where the work starts at six or six-thirty. Each apprentice is interviewed by the manager at the beginning of the evening class session, and the classes he decides to attend are entered on a card. The school is notified, and if he fails to enrol the matter is dealt with as a breach of a condition of apprenticeship. An increase of pay from 6*d.* to 2*s.* per week is granted for evening class attendance, graduated in accordance with the record of work done. Early leave to attend classes is arranged for when necessary, and in no case is an apprentice allowed to work late in the factory on one of his class nights. It has not been found possible even with this considerable amount of persuasion and insistence to induce more than about 70 per cent. of the number of apprentices in the factory each year to attend evening classes regularly. Sickness, home disabilities, and temperamental repugnance to any form of book-work prove too great obstacles to the remaining 30 per cent.

The fourth axiom—that the apprentice's training must not be determined by the foreman—is met by all changes of apprentices from one stage to the next being arranged for by the works manager. A list of these changes is sent to the department foremen about once a fortnight, and must be given effect to forthwith, no matter at what inconvenience to the work in hand. It is necessary to be explicit on this point, as otherwise the competent boy will be kept on one kind of work, to the detriment of his all-round training. In arranging for a change of work regard is had, of course, to the boy's special aptitude, more particularly in the later stages of training; and there is no objection to the foreman giving boys special experience of particular machines or processes when opportunity offers, without receiving instructions to do so. The danger to guard against and overcome is the reluctance of those in charge of the work to make changes which advance the boy's training, but at a temporary cost in output. This reluctance can only be overcome by the issue of definite instructions from headquarters.

The fifth axiom—that there cannot be too many highly-trained apprentices—is certainly true in my experience. The tendency to settle down, to give up any definite attempt to make progress, manifests itself early in the life of very many young men, and I do not think that the most strenuous efforts to persuade larger numbers to steadily advance themselves in knowledge and experience will ever produce more than—or even as many as—there are vacancies waiting for them to fill. It may happen at times that a number of ambitious and capable young men finish their training together, and they may think themselves that there is not a good prospect of their finding scope for their abilities, but it is a temporary effect, and the average over a period of years certainly proves, I think, that the demand for highly trained men is well ahead of the supply.

The sixth axiom—that special training must be given to the more able—is, I think, worth particularly careful study. It is met in the factory by a selective annual examination in subjects relating to shop practice, the result of which is combined with the result of evening class attendance, with time-keeping in the works, and with a report on conduct submitted by the shop foreman. Every quality of the boy's ability and character is therefore included in determining his place in the list which is prepared of those having the promise of executive ability. Apprentices who win a place on this list are promoted to the drawing office, are given four hours' day tuition during working hours in the winter months, and are put through a wider practical training in the factory. In certain cases they receive a set of tools, which becomes their own on completion of apprenticeship. Since it is felt that to take full advantage of this higher training a good day-school education is essential to start with, the firm have recently instituted scholarships to enable boys to attend a suitable course of instruction for one year at a secondary school before starting their workshop training. It is hoped that by this means it will be possible to ensure that every boy will have spent at least one year in a secondary school before commencing his apprenticeship.

In conclusion I may express the hope that these propositions and the short description of their application to one particular factory may be of use to those who just now are considering the question of the higher training of their apprentices, a question among the most important in relation to that general industrial betterment which we hope may result from the many changes of these troubled times.

BY RAIL FROM THE NORTH SEA TO THE PERSIAN GULF.

WE do not suppose that there are any pacifists among our readers, but it is impossible to ignore the fact that there is a small minority of people in this country who do not realise, as they should, the dangers of an inconclusive peace. To such we would recommend the careful consideration of a scheme which has been elaborated in Germany for extending the paramount influence of the Central Powers after the war from the North Sea to the Persian Gulf. The plan was elaborated before our advance to Baghdad, and may have undergone some modification since, but its main features are yet intact, and show that the dream of a world dominion still obsesses a large party among our enemies. In itself it is not new, but the wonderful military advantages of interior railway lines which has been demonstrated in the war has evoked a desire to extend them right across one continent and far into another. The facility of transferring troops by rail from the western front to (say) Monastir, as compared with the delay and expense of sending them by ship through the Mediterranean, is appreciated not only by the military but also by the civil population of Germany, and it is seen that if Britain and France could be permanently relegated to the exterior lines of communication they would be put into a position of inferiority for the entire future.

Between Germany and Persia there lie four kingdoms, each of which is now in alliance with, or in subjugation to, the predominant partner. These are Austria-Hungary, Serbia, Bulgaria and Turkey, and near by lies Roumania. It is believed that each of these can be persuaded, or compelled, to facilitate a great through railway which in time of war might be used to compel us to divide our forces, and at the same time would carry food and raw material to the Central Powers; in time of peace it would provide an enormous market for German goods. This potential market lies mainly in Asia Minor, but it will never be of great value until the Turk has been reformed. How he will like the process remains to be seen. One would think that even German control would be preferable to the rule of the Pashas, but the East hates change, even for the better. It is more than doubtful whether the fellaheen of Egypt welcome our guidance, although the iron hand is most carefully gloved, and we have abolished forced labour, the kourbash, and excessive taxation, while every man is secure of justice both in the courts and in the distribution of water on his land. Substantially similar results might follow German domination, but there would be a world of difference in the methods, not to mention the forced military service which would accompany the material improvements. However, the opinion of the peasant in Asia Minor is not likely to be studied in Berlin, and he will certainly not be encouraged to criticise his masters if they confer upon him the blessings of *kultur* in larger doses than he can comfortably assimilate.

It is clearly understood in Germany that the proposed railway can only be made to pay if it is conceived and carried out as a whole. It must secure a considerable transcontinental traffic, in addition to the local traffic, and must be under a central management which will ensure that every means will be taken not only to obtain traffic, but also to secure the greatest economy in working. In any case the expenditure must be very large and politically would have far-reaching consequences, but it is felt that coming after an exhausting war it is imperative that the commercial side of the question shall have a sound basis.

As far as Germany and Austria themselves are concerned, no building of new railways is likely to be necessary; they are traversed by a sufficiency of lines, even if additional plant may be needed in some places. The programme set forth is divided into four stages, and comprises the following aggregate of new lines to be built, or existing lines to be extended, Roumania, it will be seen from the subjoined table, being included in the scheme:—

—	1st Stage.	2nd Stage.	3rd Stage.	4th Stage.	Total
	km.	km.	km.	km.	km.
Hungary ..	1,413	673	64	350	2,500
Bulgaria ..	1,057	240	153	350	1,800
Roumania ..	606	371	—	23	1,000
Turkey ..	1,775	1,750	600	375	4,500
Total ..	..	..	..	..	9,800

The first stage comprises the following sections and extensions, and is expected to be complete in the course of three years:—

On the route from Berlin to Aleppo there is to be a second set of rails from Oderberg, in Silicia, near the junction of Germany, Russia and Austria, *via* Temesvar (in Hungary), Bazias (on the Danube, 40 miles east of Belgrade), Pirot, Sofia (the capital of Bulgaria), Constantinople, Eskischehir (100 miles south-east of Constantinople), Angora and Marasch, the latter being about 60 miles due north of Aleppo. This, of course, is the present main line to the East.

Strengthened permanent way is to be laid from Bukarest (the capital of Roumania), northwards *via* Kronstadt (in Hungary) to Szvonok (west of Budapest, in the valley of the Theiss); over Orsova (near the Iron Gates on the Danube) and Czegléd (south of Budapest); and over Rustschuk to Tirnova–Sljemen.

In Asia Minor there are the connecting lines from Lefke (90 miles south-west of Constantinople), *via* Brussa, to Balikesri (which is about 140 miles south-east by east of Constantinople), from Akshehr (the ancient Dorylæum) to Egerdir, and from Boli to Eregli (which is about 70 miles from the sea and 150 miles from Alexandretta), in connection with the coalfields of Heraklea.

The crossing of the Danube is to be effected at Bazias, a short way east of Belgrad, by means of a railway bridge; at Rustschuk, which lies due south of Bucharest in Roumania, the goods wagons are to be taken across in ferries without reloading, and the trains are to be conveyed across the Bosphorus in the same way.

The second building stage, which is to be completed within six years, embraces a second line of rails on the sections Bukarest–Orsova–Temesvar, and Pirot–Temesvar–Kisterema.

In Turkey in Asia the new line will run from Boli to Erzerum, 120 miles south of Batoum on the Black Sea, with branches to Ineboli (on the Black Sea), Amasia, Sivas, Trebizond and Charput.

The third stage is to be completed within nine years, and comprises a new line from Erzerum *via* Bitlis, south-west of Lake Van, to Mosul, which is the last stage on the way to Baghdad. By means of this line, with connection with the Baghdad Railway over Ras el Ain, a second ring is completed *via* Aleppo, Constantinople, Erzerum.

The fourth building stage comprises a second line of rails on the section Pirot–Belgrade–Budapest, and some additional auxiliary sections in Asiatic Turkey.

The above lines, in connection with the already existing sections and those in course of construction in Hungary, Bulgaria, and especially in Asiatic Turkey, form a strategic railway system of high efficiency. Turkey will obtain a system of railway lines leading to all the frontiers of Asia Minor and traversing its central districts. This, with branch

lines to parts rich in minerals, will ensure an adequate goods traffic with Central Europe both in times of peace and in times of war. All the railways above named are intended to be at once taken over by the railway departments of the countries in question and to be worked for their account on similar lines to those already existing. The passenger and the local goods traffic is to be worked according to local requirements, but the expected vast overland goods traffic is to be dealt with in an entirely new manner. The heavy goods trains, composed of large new wagons, are to be marshalled at collecting places and, as formerly, the trains *de luxe* of the Belgian Sleeping Car Company are to be despatched with all possible speed, so that the distance from Berlin to Baghdad (3,100 miles) may be covered in eight to ten days. The railway departments will have to run these trains at working cost, for if the tariffs were not low, the traffic would simply not materialise.

The goods traffic which may be expected after the war between the Central European Powers themselves and between these and Turkey, will, it is anticipated, develop in the following manner. The turnover of the allied and occupied districts of the Balkans with foreign nations, according to the figures for the unfavourable year of the Balkan war, 1913, amounted to about 6,000,000 tons, of which one-third was imports and two-thirds were exports. The turnover with Central Europe amounted to 1,500,000 tons, of which 1,280,000 tons came by way of water and only 220,000 tons by rail, so that not even 4 per cent. of the entire turnover were carried upon the railways. It is expected, however, that of the aggregate turnover by land and sea of the Balkans 1,500,000 tons will fall to the lot of the railways.

	Marks.
First stage :—	
For Central Europe—	
690 km. new lines in Bulgaria	122,000,000
60 km. improved lines in Bulgaria	4,000,000
324 km. improved lines in Hungary	20,000,000
For Roumania—	
257 km. improved lines in Bulgaria	15,000,000
50 km. new lines in Bulgaria	9,000,000
1,089 km. improved lines in Hungary	76,000,000
240 km. new lines in Roumania	53,000,000
366 km. improved lines in Roumania	22,000,000
For Asiatic Turkey—	
1,475 km. new lines in Asia Minor	232,000,000
360 km. new lines in Europe	40,000,000
For Train Ferries—	
Across the Danube at Rustschuk	4,000,000
Across the Bosphorus ...	5,000,000
	602,000,000
Second stage :—	
For Central Europe and Roumania—	
240 km. second set of lines in Bulgaria	43,000,000
673 km. second set of lines in Hungary	121,000,000
371 km. second set of lines in Roumania	67,000,000
For Asiatic Turkey—	
1,750 km. new lines in Asia Minor	350,000,000
	581,000,000
Third stage :—	
64 km. new lines in Hungary ...	12,000,000
153 km. new lines in Bulgaria...	28,000,000
600 km. new lines in Asia Minor	120,000,000
	160,000,000
Fourth stage :—	
350 km. second set of lines in Bulgaria	63,000,000
350 km. second set of lines in Hungary	63,000,000
23 km. new lines in Roumania	4,000,000
375 km. new lines in Asia Minor	68,000,000
	198,000,000

Roumania which, through the war, has for the time being been added to the Central European industrial and commercial district, had, judging from the figures for 1905–1913, imports amounting to 3,500,000 tons and exports of 4,500,000 tons, and of this turnover about three-fourths, directly or indirectly, were intended for Central Europe. When the natural resources of Asiatic Turkey are opened out, and when the railways set forth under the above four stages of construction have been completed, 1,200,000 tons to 2,400,000 tons of goods for Central European lines are anticipated, leaving more than an equal quantity of the aggregate Turkish goods traffic for sea transport by present hostile and neutral countries. According to this the Central European Powers may reckon upon a goods turnover of 3,000,000 tons amongst themselves and from 1,200,000 tons to 2,400,000 tons in their intercourse with Turkey.

The cost of railway construction and of rolling-stock, heavy goods locomotives and goods wagons of 33 tons to 50 tons capacity, with automatic brakes, for express trains of 600 tons capacity, has been estimated as under :—

In calculating the cost of the rolling-stock required, the following assumptions have been made :—Goods wagons of a capacity of from 33 tons to 50 tons ; locomotives with a haulage capacity of 1,000 tons gross load ; an average haul of 2,000 km. for all goods ; a train of 600 tons ; an annual mileage for the engines of 30,000 km. ; for the goods wagons of 15,000 km. These assumptions, with the figures referred to above and for the different stages of building, make the number of goods wagons and locomotives required after the completion of the first stage to be :—

	Marks.
20,700 goods wagons, at 9,000 marks each	186,300,000
430 engines, at 100,000 marks each	43,000,000
	229,300,000

After the completion of the second stage :—

	Marks.
9,300 goods wagons, at 9,000 marks each	83,700,000
200 engines, at 100,000 marks each	20,000,000
	103,700,000

After the completion of the third stage :—

	Marks.
22,500 goods wagons, at 9,000 marks each	202,500,000
490 engines, at 100,000 marks each	49,000,000
	251,500,000

After the completion of the fourth stage :—

	Marks.
3,500 goods wagons, at 9,000 marks each	31,500,000
80 engines, at 100,000 marks each	8,000,000
	39,500,000

The tariff for the traffic with the Balkans and Asiatic Turkey has to be adjusted to suit that of the German Levant Line before the war. These rates from a German railway station, according to its distance from a German harbour, to a harbour in the Balkans or Asia Minor, were from 30 marks to 32.50 marks per ton, including transhipment and fees for a minimum of 10 tons on one bill of lading and in one wagon, or, making allowance for certain charges, 10 marks to 25 marks for journeys in Turkey, four stages, from 500 km. to 3,000 km., in addition to 12.50 marks for the transport of Turkish goods over an average distance of 2,000 km. in Central Europe. In the same way a special tariff has been fixed for wagon loads from the Central European countries in question for the Balkan traffic of 20 marks to 28 marks per ton, in three stages, for journeys of from 1,000 km. to 3,000 km. From these figures an average rate of 1.4 pfennig per ton-kilometre (0.27*d.* per ton-mile) results for the combined Central European–Turkish goods traffic.

It goes without saying that the heavy cost of construction, for instance, of the new lines for heavy goods traffic in Bulgaria, Serbia and Hungary, cannot be defrayed by the countries in question alone, and on the other side the ownership of the new lines that will have to be built must not be interfered with. It would be undesirable for foreign States, which, after all, the allied countries will remain, should have financial or other influence upon Hungarian and Bulgarian railways. Diverging interests of the different States will continue to exist, and conflicting views may arise. It will therefore be necessary to create an independent undertaking of a legally private nature, which can take action in case of differences between the States concerned. Such an undertaking would take the form of a Central European goods traffic company, and would provide the rolling-stock, while the respective States constructed the lines. The through rates would be settled by the traffic company.

A special Turkish goods traffic company is contemplated for the extension of the Turkish State railway system, on similar lines to the Central European traffic company, and is to develop on a rational basis the Turkish goods traffic within the country and with the allied countries. It is proposed to form an intermediate company in which both the former companies are represented.

According to what may be called a prospectus, a surplus of 5,700,000 marks is reckoned upon, after provision for maintenance, &c., 5 per cent. dividend on the capital of 343,000,000 marks of the Central European and Turkish traffic companies, and 4 per cent. interest and 1 per cent. sinking fund on the State loans, amounting to 1,183,000,000 marks. These figures are expected to apply to the eighth year, after the completion of the first and second building stage.

The completion of an efficient railway service from the North Sea to the Persian Gulf, as set forth above, will, it is claimed, make the Central Powers the masters of Europe.

If such a scheme were put forward in this country it would receive scant consideration. The Government would protest it was none of their affair, while the private investor would look askance at a project which must be several years before it entered the dividend stage. In Germany matters are regarded differently. In addition to the Government and the private investor, there are corporations which can take long views. They can average their dividends over a period of years and are prepared to nurse a likely project for its future value. If the German Government were successful in the war it would put pressure on the neighbouring countries to construct the railways whether they liked to do so or not. The money could be raised on the credit of the various countries at reasonable rates, because the taxpayers would be behind the railways, and the equipment would be provided by the projected companies, who would be in a fairly safe position. Many things, however, may happen which are not included in the programme.

THE INSTITUTION OF GAS ENGINEERS.

In our issue of June 8 we gave an account of the proceedings of the first day of the annual meeting of the Institution of Gas Engineers, which concluded with an address by Mr. Guy Calthorp, the Coal Controller. Previous to it the usual votes of thanks were passed, the last being to the secretary, Mr. W. T. Dunn, to whom the president, Mr. A. E. Broadberry paid a well-merited tribute. It appears that it was Mr. Dunn who had conceived the idea of the presidency of the Institution for the year 1917–18 being offered to Lord Moulton ; and he had personally obtained his lordship's consent to be nominated for election to the office, preceded by his election to honorary membership of the Institution.

The Institution is to be congratulated on this departure from its usual practice, which is to restrict the presidential chair to members only. It is understood that Lord Moulton undertook the office to mark his appreciation of the invaluable assistance he has received from the gas industry in his position of Director-General of Explosives Supply. In acknowledging his election he stated that from the time of his appointment by the Government he had received most unstinted assistance from the gas undertakings of the country, the engineers of which had been unsparing in their efforts to produce the largest possible quantities of the essential elements which are needed in the manufacture of high explosives ; without them it would have been impossible successfully to prosecute the war.

VISIT TO THE WORKS OF THE TOTTENHAM DISTRICT LIGHT, HEAT AND POWER COMPANY.

On the following day, by invitation of the chairman (the Right Hon. Sir Daniel F. Goddard, M.P.) and directors of the Tottenham District Light, Heat

and Power Company, the members visited the company's gas works at Tottenham and electricity works at Wood Green.

There were about 300 present, and admirable arrangements were made for the guidance of this large number of visitors so that everything of special interest should be seen. Chief attention was naturally centred in the entirely new section of the works, which the chief engineer, Mr. A. E. Broadberry, M.Inst.C.E. (president of the Institution), has designed for the production of 4,750,000 cub. ft. of gas per diem, by means of a Woodall-Duckham vertical retort installation. By his courtesy we are enabled to publish the following description and accompanying illustrations on this page and on pages 587 and 588, and on Plates LXV to LXVIII. Mr. J. Fisher, the company's assistant engineer, has had charge of the actual work of designing the whole section.

Referring to Fig. 1, it will be seen that this new section has been constructed on a vacant site at the north end of the works, which was, until recently, used as a storage ground for coal. Operations were begun in the early part of 1915, but owing to circumstances arising from the war, the installation is only now on the point of completion. It is expected that the first retorts will be heated in the course of a few weeks. The new retort-house, marked 1 in the general plan, and shown in Fig. 5, Plate LXV, is a steel-framed structure enclosed with 4½-in. brick panels. The vertical stanchions have been enclosed in red brick to harmonise with the older retort-house, which was built in 1906. The upper structure and the roof are supported jointly by the framework of the walls and by the steel framework of the retort settings themselves. The outside producers are erected in the same building. The upper portion has been extended to cover the coke hoppers also.

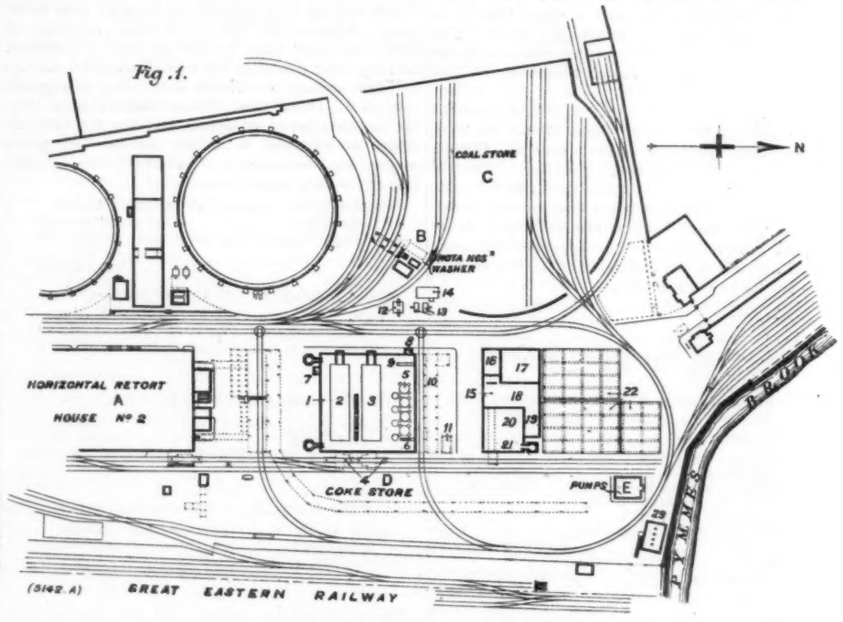
The arrangement of the power-house, marked 18, 19 and 20 on Fig. 1, is shown in Figs. 2 to 4 on page 587, in which will be seen the gas, steam and exhaust connections, &c. There are two electric generating sets of 150 kw. each, direct current, 220 volts. The generators have been supplied by the Electric Construction Company, of Wolverhampton, and the compound, high-speed, vertical, enclosed engines by Messrs. Bellis and Morcom. Provision is made for a third engine, which may be either larger or smaller than the existing sets, when the maximum and minimum demand has been determined after the plant is in full operation. The steam from the engines and turbo-exhausters will be passed through an oil separator supplied by Messrs. Holden and Brooke, and thence to a condenser with rotary air pumps electrically driven, constructed by the Rees Roturbo Manufacturing Company, of Wolverhampton. The condensers are fixed immediately above a cool-water tank under the engine-room floor, while a division of the same tank coming under the adjoining pump-room is used as a hot well, the water from which is taken by means of centrifugal pumps with automatic controlled gear, supplied by the Pulsometer Engineering Company, and delivered to a cooling tower marked 23 on the plan, and shown in Fig. 12, Plate LXVII. The water returns from it to the cool tank through an equilibrium valve, by means of which the level is regulated. Messrs. May and Haines, electrical engineers, have been acting as consulting engineers for the electrical equipment.

In the pump-house (19) are two electrically driven "Sirius" pumps for circulating water to the outside producers and the hot-gas condenser; three boiler feed pumps by the Worthington Pump Company; one water pump by Messrs. Lee, Howl and Co. for the water supply to the top of the retort benches; and two tar and liquor pumps by Messrs. Joseph Evans and Co. There also will be a vacuum pump for exhausting the siphons on the gas mains of the section; and a feed water heater.

Four Babcock and Wilcox water-tube boilers are provided, working at a pressure of 120 lb. per square inch, each designed to evaporate 4,000 lb. of water per hour and fitted with steam superheaters. The boilers are worked by forced draught grates supplied by Messrs. Hoodrich and Hamlyn, to burn breeze. The boiler fuel plant is indicated at 21. Breeze or coke from the other parts of the works can be delivered from trucks into a gravity bucket conveyor and stored in bunkers immediately over the front of the boilers. This plant has also been installed by Messrs. Babcock and Wilcox.

Fig. 5, Plate LXV, is from a photograph of the new retort-house, and Fig. 6 from that of the coal bunkers. The position of the coal-receiving hoppers, coal breakers and gravity bucket conveyers is denoted by No. 4 on the general plan. The discharging of the coal will be by up-ending the coal wagons and discharging through end doors. It should be noted that the tipping rams are provided with a steel-framed carriage, one end of which runs on rails between the main line. When the end of the carriage is raised this steel carriage engages the front axle of the wagon. The whole of the wagon can then be raised to clear it entirely of coal without the front hoppers coming into contact with the railway metals. The coal is delivered through a jigging screen to an electrically-driven coal breaker and thence to a gravity bucket conveyer, by means of which it is

Fig. 1.



REFERENCE NUMBERS TO NEW SECTION.

1. Retort house.
2. Vertical retort bench
3. Vertical retort bench.
4. Coal-breaker pits.
5. Outside producers.
6. Turbo-blowers.
7. Passenger lift.
8. Ash hoist.
9. Breeze elevator.
10. Coke hoppers.
11. Tar and liquor tank.
12. Hot washer.
13. Condensers.
14. Water softener.
15. Apparatus buildings.
16. Turbo-exhausters.
17. Washers and scrubbers.
18. Engine-room.
19. Pump house.
20. Boilers.
21. Boiler fuel plant.
22. Reinforced concrete purifiers.
23. Cooling tower.
A. Horizontal retort house No. 2.
B. "Nota Nos" washer.
C. Coal store.
D. Coke store.
E. Pumps.

elevated to the coal-storage bunkers above the retort benches. The whole of this plant has been designed to deal with 100 tons of coal an hour. The same conveyer will be utilised for the removal of coke from the retorts.

A special electrically-driven filling arrangement, mounted on rails, will traverse the retort bench from end to end, for the removal of the coke, which will be discharged from the gravity-bucket conveyers before reaching the top hoppers, on to a tipping tray conveyer, by means of which it will be conveyed to the producers or the screens over the coke hoppers, as may be required. Messrs. Babcock and Wilcox have constructed the coal and coke-conveying plant to the requirements of the Woodall-Duckham Company, under that company's contract.

Fig. 7, Plate LXVI, shows the purifier buildings completed, while Fig. 8 was taken during the course of their erection. The purifiers, which are of reinforced concrete (see Figs. 17 to 29, page 588) are each 56 ft. by 42 ft. 6 in. by 6 ft. 6 in. inside dimensions. The gas will be divided in each box so as to pass upwards and downwards through one layer of oxide. Messrs. Walter Jones and Sons have built the purifiers to Mr. Broadberry's design. Many ideas were suggested by seeing those at the Brentford Gas Works. The covers, constructed by Messrs. R. and. J. Dempster, are fitted with their patent rubber joint. They are lifted and traversed by means of traversing hydraulic jacks which run on narrow-gauge railways. The purifier grids, which are of a new type, have been made in the Tottenham Gas Company's shops.

Fig. 9, Plate LXVII, gives a view of the outside gas producers, of which there are four. They have been constructed by the Power Gas Corporation, Limited, of Stockton-on-Tees. Each is designed to gasify 20 tons of coke breeze per day and is 8 ft. 6 in. diameter inside the firebrick lining. They are erected in a row, with an operating platform common to all. The gas outlets are connected through dust catchers and mushroom type valves to a common gas collecting main. Two steam turbo-blowers, each capable of meeting the requirements of three producers, provide blast for the plant. The rotating grates are operated by electric motors, installed in duplicate, one being spare; the drive is by belt. In this type of producer there is a combination of steel shells having the lower portion water-cooled and the upper part lined with refractory brickwork. Each producer has a rotating grate mounted eccentrically on a water-luted ash-discharge pan. The steel shell has the water-cooling jacket so placed as to provide a water-cooled metal surface in that zone of the producer where clinker usually forms, thus preventing clinker from adhering to the walls. With the gradual descent of the fuel the clinker falls to the rotating grate, where it is crushed against the specially prepared grinding surface at the bottom, and passes into the luted ash pan.

When the producer is operating the pan fills up with mixed crushed clinker and ash, which, as the pan revolves, is forced against a stationary adjustable plough blade, and is discharged on to the ground, or, as is usually arranged, into ash trucks alongside the producer. The air blast enters underneath the grate and passes, by means of a luted pipe, up to the cone of the grate, and through this on to the fuel bed. The grate, with ash pan rotating on a ball race, is actuated by worm gearing fitted with variable feed ratchet attachment arranged for driving by eccentric and rod from a shaft alongside the producer. There are the usual fittings—hopper with lever-operated cone valve and balance weight; cover, top ball poke holes, &c. The water outlet is so arranged that the jacket is always full of water and free of any air space, thus minimising the possibilities of corrosion. The water which is

discharged provides a supply of hot water which may be used for boiler feed or other purpose.

In order to ascertain the results obtainable with the breeze from the Tottenham works, a supply was sent to the makers of the producers and gasified. The results showed that 110,000 cub. ft. of gas could be produced from one ton of wet breeze, the analysis of the gas being CO_2, 6.4 per cent.; CO, 25 per cent.; and H_2, 14 per cent.; ash, 87.3 per cent., incombustible; carbon, 10.73 per cent. The calorific value of the fuel was 11,109 British thermal units per pound on a dry sample. The net calorific value of the gas produced was 124 British thermal units per cubic foot.

The gas from each producer passes through a "Cyclone" dust extractor into a trunk main, and thence through two other dust extractors into mains running along each side of the retort house, and again to branch mains situated between the coke-receiving hoppers under the retort benches.

A photograph of the top of the coke bunker is reproduced in Fig. 10, Plate LXVII. The breeze and very fine coke coming from the coke screens is elevated to a band conveyer and delivered to the hoppers over the producers. These hoppers can be supplied either with coke direct from the retorts or with breeze screened from the coke. The main coke hoppers, Fig. 11, Plate LXVII, owing to the great height of the vertical retort benches, are made of very considerable size. The coke is delivered by a tipping-tray conveyer on to two Norton screens, either of which is of sufficient capacity to deal with the maximum quantity of coke. The bottom outlets of the coke hoppers are arranged for loading into trucks, and also, on the northern side, into coke sacks and paper bags. On this side a concrete coke-loading plant is constructed; and between the stage and the railway line a narrow-gauge railway is run for collecting breeze removed by the bottom screens and conveying it to the boiler fuel plant.

For dealing with the surplus coke a service hopper is constructed under the end of the tipping-tray conveyer, whereby coke can be delivered into a smaller hopper, and thence taken in narrow-gauge trucks on an overhead gantry either to an existing coke store or to a coke yard which it is proposed to construct on the western side of the works, where at present the reserve of coal is deposited.

The position of the cooler tower is indicated by No. 23 on the general plan. Fig. 12, Plate LXVII, is a photograph of the apparatus. It has been constructed by the Premier Cooler and Engineering Company, Limited, and does not call for special comment.

A photograph of the charging stage of the vertical retorts is given in Fig. 13, Plate LXVIII. Each bench of retorts comprises seven settings of four retorts. The retorts are 5 ft. 3 in. by 7 in. at the top. Each retort will carbonise 6½ tons of coal per diem, so that the maximum capacity of both settings is 364 tons a day.

Fig. 14, Plate LXVIII, is a view of the producer charging stage. It should be pointed out that the incoming fuel gas and secondary air are both pre-heated by tubular regenerators between the waste gas flues and the bottom portion of the retort itself. It is hoped by this means to cool the coke more effectively than by the usual methods. At the same time an easy travel for the waste gases to the chimney is obtained.

The coal tippers are illustrated in Fig. 15, Plate LXVIII, and Fig. 16 shows the condensers and hot washers, of which there are two. These have been constructed by Messrs. Ashmore, Benson, Pease and Co. They are fitted with horizontal tubes, and special four-way valves are provided between the hot washer and condensers, so that their positions can be varied to suit the requirements of gas-making. In the water-softening plant, denoted by No. 14 in the general plan, the water from the second condenser is supplied to it in its hot condition. It passes to the main tanks in the engine-room, for making up condensation losses.

The exhauster-house (No. 16 on the plan) contains

Fig. 2. LONGITUDINAL ELEVATION A.A.

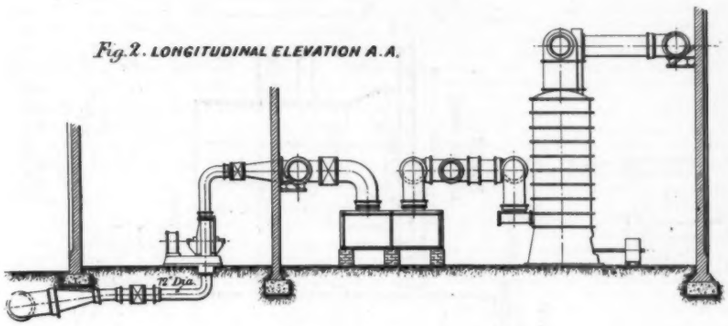


Fig. 3. SECTIONAL ELEVATIONS B.B. AND C.C.

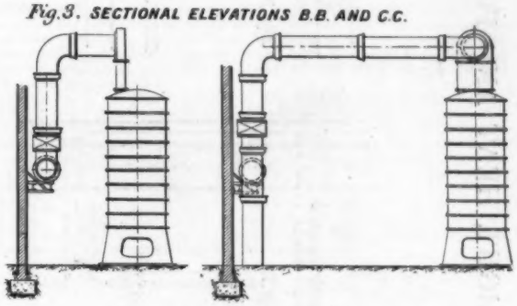
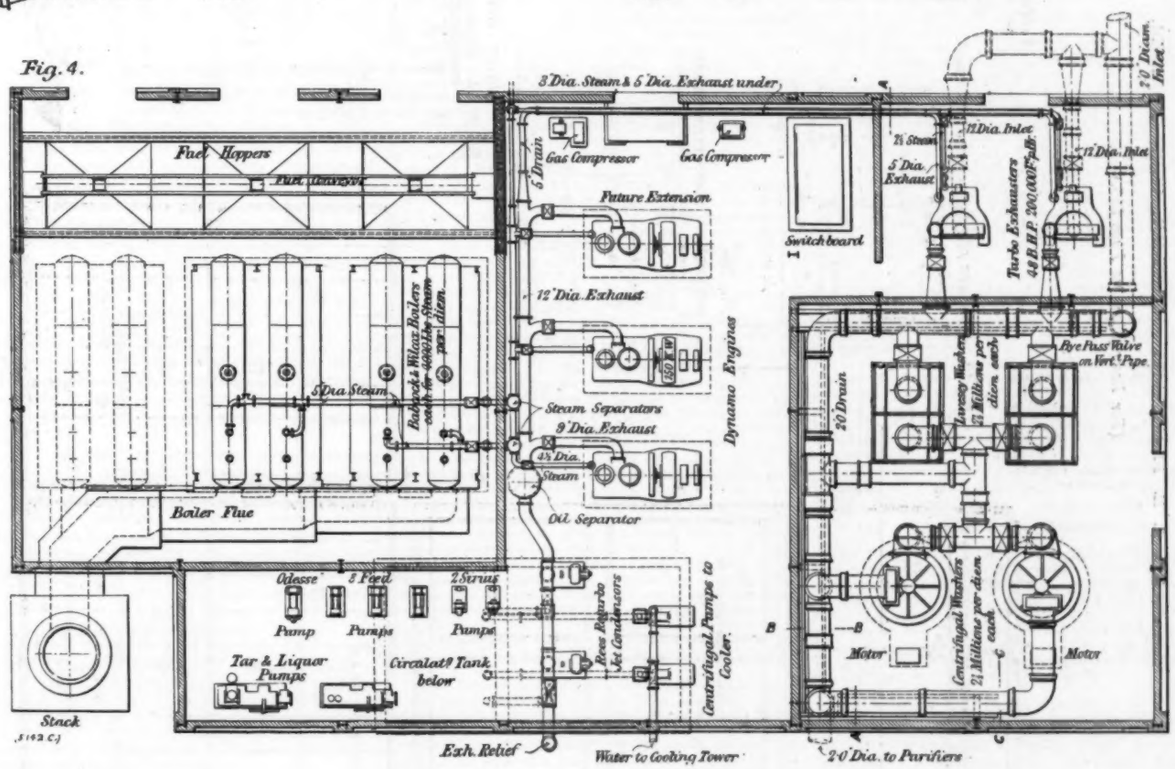


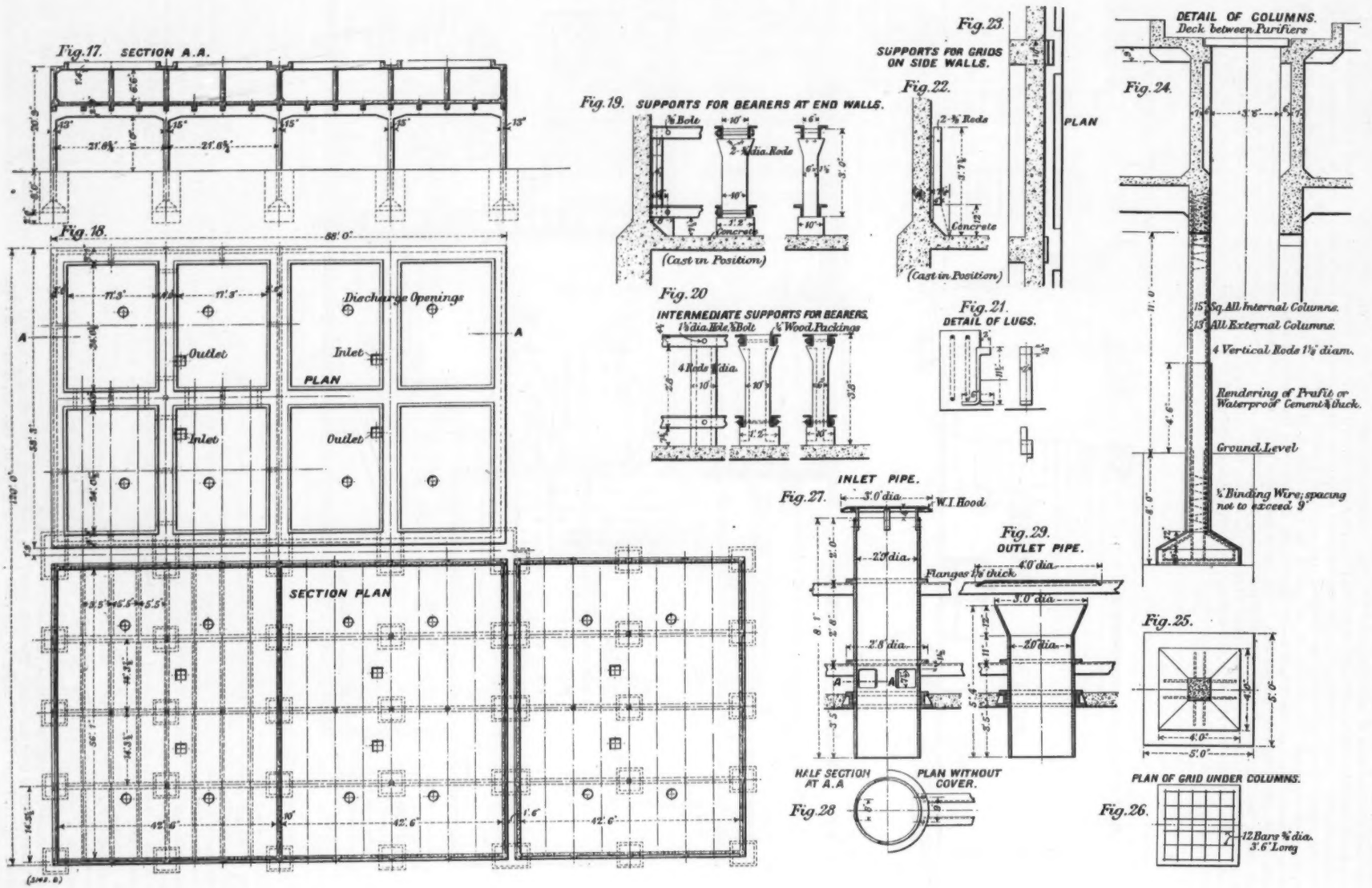
Fig. 4.



REINFORCED CONCRETE PURIFIERS AT THE WORKS OF THE TOTTENHAM LIGHT, HEAT AND POWER COMPANY.

MR. A. E. BROADBERRY, M. INST. C.E., CHIEF ENGINEER.

(For Description, see Page 585.)



two turbo-exhausters, constructed by the British Thomson-Houston Company. Their capacity is 200,000 cub. ft. per hour each. They are driven by two two-stage Curtis turbines, which will run condensing. They will be controlled by Donkin governors.

No. 17 in the general plan Fig. 1 refers to the washer and scrubber house. In it are two Livesey washers, supplied by Messrs. Ashmore, Benson, Pease and Co. There will be, eventually, two centrifugal scrubbers, electrically driven, from Messrs. Kirkham, Hulett and Chandler.

In the afternoon of the visit many of the members went on to the company's electricity works at Wood Green, which is situated about 2¼ miles from the gas works. At these works the supply is on the direct-current three-wire system at 480 volts and 240 volts. There are two generating sets—one of 200 kw. and one of 100 kw. Both are driven by five-cylinder vertical high-speed engines, constructed by Messrs. Hindley and Sons, of Bourton, and using town's gas for motive power. They are started up by means of compressed air. The jacket water is cooled by Heenan and Froude rotary coolers. The engines are direct-coupled to tandem direct-current generators mounted on the same bedplate as the engine. They were supplied by the Electric Construction Company, as was also the switchboard. Under test conditions, with gas of 500 British thermal units net, the larger of the two sets realised an efficiency corresponding to the consumption of less than 30 cub. ft. of gas per unit generated.

There is a battery of accumulators of 840 ampere-hours' capacity, supplied by the Chloride Electrical Storage Company, and for charging the battery there is a combined set of motor and two boosters by the Electric Construction Company. The electric cables are three-core paper-insulated, lead-sheathed, armoured and jute-covered. They were supplied and jointed by the Western Electric Company, Limited. The pillars and boxes are from Messrs. Lucy and Co., and the meters from Messrs. Chamberlain and Hookham, Limited.

There are at the present time 179 meters connected and 39 motors, totalling about 125 h.p. The maximum demand so far experienced is 95 kw., and up to the middle of May the units sold this year amounted to 48,000, which, allowing only the present output for the remaining part of the half-year ending June, will make the total for the complete six months 58,000 units, giving a load factor of 14 per cent. based on the maximum demand.

For the excellent arrangements made for the reception of the members at the Tottenham works their thanks were expressed by Mr. Harry E. Jones, a past-president of the Institution and a vice-president of the Institution of Civil Engineers.

We intend in subsequent issues to deal with the Tottenham company's new gasholder, and with other details of the important extension of their works.

THE PHYSICAL SOCIETY OF LONDON.

AT the meeting of the Physical Society of London, held on May 25, at the Imperial College of Science, Mr. W. R. Cooper, M.A., vice-president, in the chair, a paper, entitled "*An Investigation of Radium Luminous Compound*," by C. C. Paterson, J. W. T. Walsh and W. F. Higgins was read by Mr. Paterson.

The paper contains the results of measurements made on various samples of radium luminous compound during the last two years. Determinations of the brightness of the compound in powder form and when made up into paint, and also after the application of the paint to instrument dials, were carried out; and curves are given showing the rates of decay of luminosity. The radium contents of the compounds were determined by comparison of their γ-ray activities with that of a preparation of pure radium bromide, which is periodically compared with the British radium standard. The various precautions which have to be observed, and the corrections which have to be applied in making the various determinations are explained, and the considerations which should govern the proportion of radium employed for practical purposes are discussed.

Discussion.—Mr. F. H. Glew: The difference between some of Marsden's results and those of Dewar and Crookes had been attributed to some difference in the zinc sulphide employed; he could state that the sulphide supplied to the National Physical Laboratory was of different origin from either of these. Before the war we were almost entirely dependent on foreign sources for the supply of these materials, but we are now quite self-supporting. In Marsden's work the inside of the tube was completely coated with sulphide, so that the effects were observed by light transmitted through the material. It was better to paint only one-half of the tube, so that the inner surface, which was exposed to the bombardment, could be directly observed. In the photometer measurements, was there any advantage in placing the coloured filter between the light and the reflecting surface? He preferred to have it in the eyepiece. Earlier records of the coloration due to absorption would be of value. In testing sulphide for γ-ray activity he placed it in contact with the ionisation chamber. Less material was then required for the test, which was an advantage. The authors stated only the diameters of the tubes employed; but he had found that there were differences in the results obtained with tubes horizontal or vertical. The length of the tube, therefore, appeared to be an important factor. Further, the results given by a small quantity of sulphide in a large tube would be too high; for the space above the sulphide was filled with the emanation gas, and the γ radiation from it was not subject to the absorption of the sulphide, as was the radiation from the latter itself. The discrepancy between the observed and calculated values of the absorption was probably important. Was this due to some selective action, the sulphide transforming the γ radiation into radiation of some other type? It was singular that specimens prepared by the dry and wet methods should be so similar in their properties after only four days; for in the dry method the emanation and all its products were retained.

Dr. Makower stated that by using an electroscope of small capacity good γ-ray measurements could be obtained with much less than 1 mg. of radium.

Dr. H. S. Allen asked if the zinc sulphide employed was wholly crystalline or partially amorphous. An investigation of its physical condition would be useful.

Professor Clinton said that the difficulties of these measurements were very great and the authors were to be congratulated on having overcome them so effectively.

Mr. J. S. Dow said the figures for the absolute brightness were what he would have expected. He was doubtful of the possibility of expressing the brightness accurately; consistent results could be obtained, but they did not represent exactly what the eye saw. For instance, zinc sulphide and cadmium sulphide may be equally bright a few inches away, but the former will look much brighter at a distance. The information as to the correct proportion of radium to employ was important. What was the brightness physiologically necessary for these purposes? He thought that less brightness than was customary might be advantageous, as he sometimes experienced an appreciable glare from the markings, which detracted from their legibility. The selection of a proper coloured glass was important for these measurements. Had the authors noticed any change of colour as the compound got older? He thought it got greener as it aged. The initial rise in the luminosity curves for the weaker materials seemed greater than could be explained by the lower rate of decay.

Dr. Levy said he had found the luminosity of different samples of zinc sulphide to vary perceptibly in tint when stimulated by daylight, but had not noticed this with α-ray stimulation. In his experience, if a sample of sulphide gave good results when stimulated by daylight, it would also be good when stimulated by radium. The reverse did not hold, however, as a specimen might be poor with daylight, but good with radium excitation.

Mr. T. Smith thought the coloured filter used in the photometric measurements should have been placed as near the lamp as possible, since such a filter acts, to a certain extent, as a self-luminous source. If the tube containing the compound was not much wider than the aperture in the screen, a considerable loss of light would occur, near the edges of the aperture, due to oblique internal reflection at the walls of the tube. For accurate work it was important to have a uniformly illuminated field, and he suggested the desirability of employing tubes with a flat side. Where the tubes were too small to fill the aperture satisfactorily, an optical system could be used to give an enlarged image of the tube and so avoid refractions at large angles. The absorption of the system could be found experimentally with a larger tube.

Dr. A. Russell laid stress on the practical importance of the paper. He had at times been asked by manufacturers to measure the visibility of watch faces in the dark. The problem was so difficult that hitherto he had done nothing. The present paper suggested the required practical tests, and a first draft of a specification for securing a standard material could now be written. Progress would be delayed if they waited till all the associated physical and physiological problems were cleared up.

Dr. S. Russ (in a communication which was read by the secretary) said the decay curves differed appreciably from those of Marsden for Willemite under intense α-ray bombardment. Did the theory held by the authors as to the mechanism of the action differ from that advanced by Professor Rutherford to explain Marsden's results? Had the authors any measurements of the rate of decay of efficiency of fluorescent screens under the action of X-rays?

Mr. Walsh, in reply, said that if the coloured filter were employed in front of the eye, as suggested by Mr. Glew, its coefficient of transmission for the light emitted by the compound would require to be determined and introduced in the results as well as the coefficient for white light. This would add to the uncertainties of the determinations. To detect change of colour with age would have been difficult in their experiments because of the continuous decrease in luminosity. They had detected differences in colour in samples sent by different makers; but were unaware whether these were from the same source, or made in the same way. They had no data on the relation between daylight and radium excitation, and Dr. Levy's remarks were of great interest. The order of accuracy (about 1 per cent.) was not found to be appreciably affected by altering the position of the coloured screen. The diameter of the smallest tubes usually employed was not less than about twice the apparent width of the aperture. It was not convenient to use a smaller aperture, and they had to do their best with the tubes in which the material was sent.

Mr. Higgins, replying to Dr. Makower, said that they had to employ the radium standards which were available, and these were not suitable for use with a small-capacity electroscope. In reply to Mr. Glew, the tube should not be close to the electroscope. If it was 30 cm. to 40 cm. off the orientation of the tube was of little importance, and small corrections could be applied. The errors introduced by having it too close were similar in character to those produced if an extended source of light is used too near a photometer head. They suspected selective action to be at the root of the discrepancy in the absorptions, but could not definitely say. To investigate the physical properties of the sulphide would be a very long task, and they had not attempted it in the present research.

A paper, entitled "*The Resistance to the Motion of a Lamina, Cylinder or Sphere in a Rarefied Gas*," was read by Mr. F. J. W. Whipple. In this paper the investigation is carried out on the assumptions that the free paths of the particles of the gas are long compared with the dimensions of the moving body, and that the motion, relative to the body, of the particles which rebound from it depends only on its temperature. It is shown that if v, w be the components of velocity perpendicular to the surface of a lamina and parallel thereto, the corresponding components of the resistance are

$$(4+\pi)\sqrt{\frac{3}{2\pi}}\frac{v}{V}p \text{ and } 2\sqrt{\frac{3}{2\pi}}\frac{w}{V}p,$$

where V is the standard (root-mean-square) speed of the gas-particles and p is the gas pressure.

The resistance to the motion of a cylinder or a sphere is found to differ very slightly from the resistance to a lamina occupying the central section. The formulæ are applicable to the problem of the damping of the oscillations of a system suspended in a rarefied gas.

Discussion.—Mr. G. D. West called attention to the fact that the author's value for the ratio of the normal to the tangential resistance of a lamina was in good agreement with that previously obtained by Knudsen. This experimenter had also deduced a formula for the resistance of a sphere moving in a rarefied gas, and it would be interesting to see how this result compared with the author's. In connection with the damping of vibratory motion a large amount of careful work had been done by Hogg.

Mr. D. Owen was not sure that Knudsen had succeeded in proving the assumption as to the manner in which the gas molecules recoiled from the surface. As the difference involved was somewhat large, he would like to see an expression added for the case of elastic spheres rebounding off a perfectly plane surface.

The formula holds only for values of λ large in comparison with the dimensions of the vessel. If the pressure is 1 μ, λ = 10 cm., and if 10 μ it is 2 cm. Would this be called large in comparison with dimensions of 10 cm.? Exact measurements of pressure and damping would be interesting in view of the uncertainty of the exact constant.

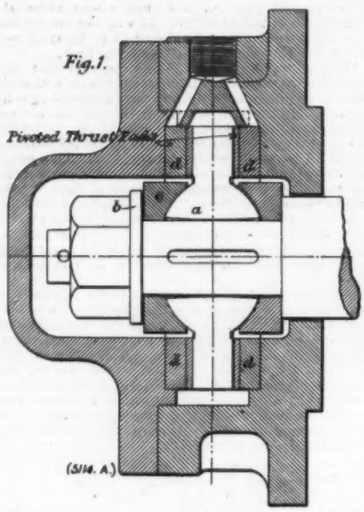
A paper, entitled "*The Effect of Stretching on the Thermal Conductivity of Wires*," by Professor C. H. Lees, F.R.S., was taken as read.

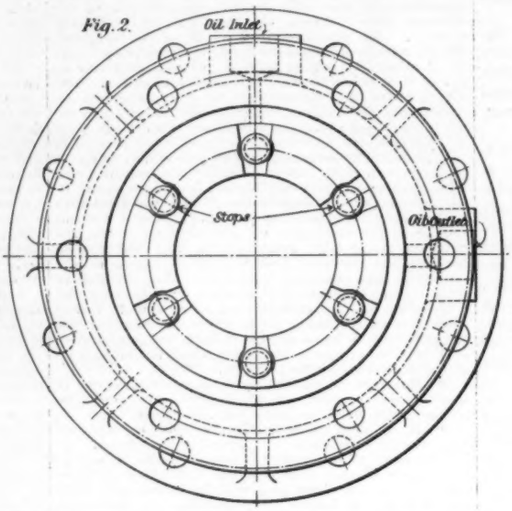
THE 15,000-KW. TURBO-ALTERNATOR AT LOTS-ROAD—ERRATUM.—We regret that owing to an error in the data given us we stated that Messrs. Glenfield and Kennedy, Limited, of Kilmarnock, supplied for the circulating water conduit at Lots-road the sluice valves illustrated by Figs. 71 and 72, on page 540 of our issue of June 8 last. The valves used, however, we now learn, were actually furnished by Messrs. J. Blakeborough and Sons, of Brighouse, to whom our apologies are due.

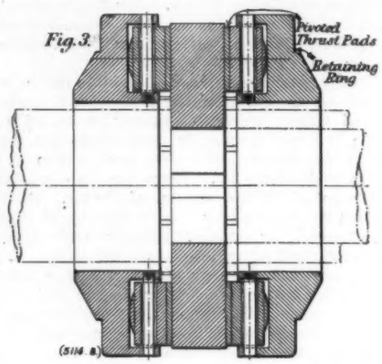
THE SOCIETY OF CHEMICAL INDUSTRY.—The annual meeting of the Society of Chemical Industry will be held this year in Birmingham on the three days July 18 to 20 (Wednesday to Friday), 1917, under the presidency of Dr. Charles Carpenter, who will deliver his address on the morning of the first day. The meeting is to be a Congress on the Progress of Chemical Industry and Applied Chemistry, the chief subjects for discussion being: Wednesday afternoon. Refractory materials (papers by Messrs. W. G. Fearnsides, W. C. Hancock, H. Watkins, P. G. H. Boswell). Thursday morning: Fuel (papers by E. W. Smith, W. J. Pickering); sources of benzol and toluol for explosives (T. F. E. Rhead); industrial applications of town's gas (C. M. Walter). Thursday afternoon: Synthetic nitrates and nitric acid (E. K. Scott, E. B. Maxted); chemistry of vulcanisation, scientific needs of rubber industry (D. F. Twiss, B. D. Porritt). Thursday afternoon, group II: Metallurgical papers (T. Turner, H. W. Brownsdon, J. Kent Smith, J. E. Fletcher, J. H. Stansbie, F. Johnson, F. C. A. H. Lantsberry). Friday morning: Organisation and co-operation of industrial research (two papers; H. W. Rowell); artificial silk (L. P. Wilson); activated sludge (E. Ardern); future of fine chemical industry (E. W. Wann). Friday afternoon is reserved for visits to works. Intending visitors should make early application to the honorary secretary of the meeting, Mr. F. R. O. Shaughnessy, of 42, Temple-street, Birmingham.

MICHELL THRUST BEARINGS.

CONSTRUCTED BY MESSRS. BROOM AND WADE, LIMITED, ENGINEERS, HIGH WYCOMBE.







MESSRS. BROOM AND WADE, LIMITED, of High Wycombe, Berks, are now standardising certain sizes of Michell thrust bearings, with a view to making them in quantity and supplying them on the same basis as that on which ball bearings have long been sold. In this way earlier deliveries can be given than are possible when each bearing is made to a separate order, and there are, of course, obvious advantages from the manufacturing standpoint. One form of standardised design is illustrated in Figs. 1 and 2 above. In this case the thrust collar *a* is bored to a barrel section and instead of being clamped between its spherical seats is loosely held, as is indicated by the space shown between the washer *b* and the opposing face of the seat *c*. It is thus capable of taking slight tilts so as to distribute the load equally, in spite of any bending or deflection of the shaft. The collar transmits the thrust to the series of pivoted blocks or pads shown in position at *d d*—of these one set serves to take a thrust and the other a pull. Provision is made, it will be seen, for a continuous supply of oil. This pattern, being entirely enclosed, is suitable for use on pumps, fans or worm gears. Another form of standardised thrust block is shown in Fig. 3. Here the bearing is not complete in itself, but is designed to fit into seats machined for it in the gear casing or whatever other machine part to which the bearing is to be applied. In this case the blocks are, it will be seen, mounted on two retaining rings. These, when the bearing is mounted in place, fit on bevelled seats, sufficient freedom being allowed to permit of the pressure being fairly distributed over the pads. The rings are prevented from being carried round with the revolving shaft by feathers on the housing of the machine. This pattern is made in sizes to fit shafts from 1 in. up to 3¼ in. in diameter, and to carry loads from 1,000 lb. to 8,000 lb. In this case the pads pivot about a point contact, whilst in the case of the pattern represented in Figs. 1 and 2, which is intended for heavier loads, the pads have line contact with the housing. Both types of bearing can be run at very high speeds, since centrifugal action in no way affects their working. With loads of 400 lb. to 500 lb. per square inch the coefficient of friction is commonly about 0.0015.

THE SPITZBERGEN COALFIELDS.—Hopes have been expressed, in these times of international coal famine, that the Spitzbergen coal deposits might help at least the Scandinavian countries, but matters do not seem to progress very favourably. The contemplated Norwegian company for the exploitation of the so-called Svalbard coalfields at Advent Bay and Green Harbour, with a capital of 170,000*l*., has not materialised, the funds not being fully subscribed and money not being found by other methods. The scheme, principally started by Norwegian shipowners, has therefore been abandoned in the original shape, but a company will be formed to protect the rights in question. It remains to be seen whether the Swedes will be more successful. The Swedish expedition for coal-mining in Spitzbergen is about to start, and comprises about 150 men, of whom 100 are to winter there. For the present year only a few thousand tons of coal are expected to be worked, but a great deal of preparatory work has to be done before rational coal-mining on a large scale can commence.

SHERRIFF'S SHELL CARRIER.

WE annex illustrations of a neat form of shell carrier designed and patented by Mr. R. R. Sherriff, of 76, Kettlebaston-road, Leyton, London, E. 10. The device, which is being made in several sizes, is intended for handling not only shells, but steel billets and forgings, our illustration, Fig. 2, showing it employed for carrying a shell for a 12-in. howitzer. The device consists of a skeleton frame mounted on two wheels and carrying above it a lever, the short end of which is

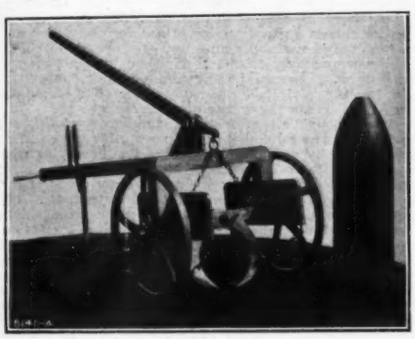


FIG. 1.

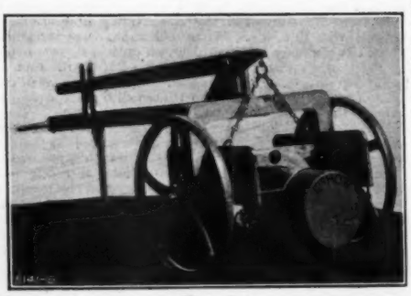


FIG. 2.

coupled by a pair of short chains to the arms of a pair of grips. In Fig. 1 the long arm of the lever is raised and the grips lowered and opened ready to grasp a shell or forging. By depressing the long arm of the lever the grips are first closed and then raised, bringing the shell or forging clear of the ground as shown in Fig. 2, when the long arm of the lever is secured by a pin. We are informed that the carrier enables a forging weighing over 1,000 lb. to be easily handled by one man.

MESSRS. KÖRTING BROTHERS.—The firm of Körting Brothers, Lindau, near Hanover, has sold its Italian factory to a Swiss syndicate.

EXPORTS TO RUSSIA *via* SCANDINAVIA.—In view of the scarcity of tonnage and of the importance of reducing congestion of traffic in Norway and Sweden, all persons desirous of exporting goods to Russia *via* Scandinavia should send full particulars as soon as possible to the Transito Department of the Russian Government Committee, India House, Kingsway, W.C. 2, who will endeavour to arrange shipment. In the case of goods whose export is prohibited application should only be made when the necessary permission has been obtained, and the number of the relative War Trade Licence or Commission Internationale de Ravitaillement Permit should be quoted.

MINERALS IN CANADA, 1916.—From the preliminary report on the Mineral Resources and Statistics of Canada, drawn up by Mr. John McLeish on behalf of the Department of Mines, we see that the war stimulated the production of nickel, copper, zinc, iron and steel, molybdenum, and also of chromite and magnesite, whilst the dearth of skilled labour impeded progress; most metals were mined in larger bulks, lead and silver being exceptions. The total gold production amounted to 926,963 fine oz., valued at 19,162,025 dols., these figures being slightly higher than those of 1915; 26 per cent. of the gold was derived from placer mining, 54 per cent. from bullion and refined gold, and 20 per cent. from matte, blister copper, &c. The production of silver was 25,669,172 fine oz., against 26,625,950 oz. in 1915; most of this silver, 21,885,057 oz., came from the Cobalt mines. The copper production has considerably increased during the past three years; the figures for 1916 and 1915 were 119,770,414 lb. and 100,785,150 lb.; most of this was from blister copper and matte; an electrolytic copper refinery was started at Trail late in the year, with a daily production of 10 tons of copper. The total nickel production amounted to 82,958,64 lb., against 68,308,657 lb. in 1915. The 80,010 tons of matte produced in the year contained 82,596,862 lb. of nickel and 44,859,321 lb. of copper; at Deloro, Thorold and Welland nickel is recovered in smelteries, as metal, oxide or sulphate, from the ores of the mines at Cobalt. These ores, from Cobalt and the Temiskaming district in northern Ontario, contain 4 per cent. to 10 per cent. of cobalt, 2 per cent. to 8 per cent. of nickel, 15 per cent. to 40 per cent. of arsenic, and from 500 oz. to 5,000 oz. of silver to the ton; the absence of sulphur and lead in these ores is their remarkable characteristic. The export of rich cobalt ores to the United States has diminished very much, but low-grade ores still go there; a few mining companies at Cobalt now desilver their ores; before the war there were exports to Germany; some ore goes to England, most of it is dealt with in southern Ontario. We have noticed on other occasions the attempts made in Canada to raise the cobalt industry; new is the high-speed alloy of cobalt, chromium and tungsten (free of iron) called "stellite," which is said to be far superior in cutting speed to tool steel. The total production of cobalt (metal, oxide, &c.) amounted to 841,859 lb. in 1916. Of molybdenite MoS_2 159,000 lb. were produced; ferro-molybdenum is made in Orillia and in Belleville, both in Ontario. The pig-iron production totalled 1,169,257 short tons; to these are to be added 28,625 tons of ferro-metals made in electric furnaces. The value of the asbestos produced in 1916 was the highest on record, though in bulk the year 1913 stands first; from 1,822,461 tons of asbestos rock sent to the mills 112,832 tons (6.3 per cent.) of asbestos fibre were recovered. We mention a few other mine products: coal, 14,461,678 tons; zinc, 23,515,030 lb.; gypsum 341,618 tons; magnesite, 55,413 tons; pyrites, 309,411 tons; quartz, 135,803 tons; salt, 124,033 tons; natural gas, 25,238,568 cub. ft.; petroleum, 198,123 barrels, all in 1916.

THE WINDOW-GLASS MACHINE.*

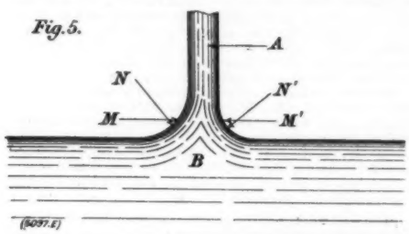
By ROBERT LINTON.

(*Concluded from page* 568.)

Closer Regulation of the Air supplied to the Interior of the Cylinder.—Lubbers had discovered three fundamental facts in his earliest experiments: First, that the air supply must be held at constant pressure; second, that unless the quantity of air supplied to the interior of the cylinder was constantly and uniformly increased during the drawing operation, the cylinder would taper off to a point; and, third, that no ordinary type of hand-manipulated valve on the air inlet line would regulate the increase delicately enough. We have seen how these conditions were provided for by using a gasometer for regulating the air pressure and the special automatic graduating valve for controlling the rate of increase of the air supply.

As the length of the cylinders was increased, another complication entered. It was found that even with the graduating valve opening and increasing with automatic precision the amount of air entering the cylinder, the pressure at the point of draw was not constant, but was applied in a series of surges which produced corrugations in the cylinder, termed "pulsations." For the purpose of better understanding the cause of these, let us consider

Fig.5.



the condition of the glass at the point of draw, and some of the factors affecting the air pressure inside the cylinder.

In Fig. 5, A represents the wall of a cylinder being drawn from the bath of liquid glass B. The surface tension of the glass in the meniscus outside the cylinder is N, and N′ the surface tension of the meniscus inside the cylinder. Now N will always be greater than N′, because the surface of the glass in the pot outside the cylinder cools by free radiation and convection in the atmosphere, while the surface of the glass inside cools by radiation through the cylinder and convection currents set up by what air is confined within the cylinder. The difference is doubtless very slight at the beginning of the draw, but increases gradually as the draw progresses. Now, since N is greater than N′, the wall of the cylinder will be gradually pushed over towards N′, unless held out by pressure. If we call M and M′ the horizontal components of the force due to surface tension on the outside and inside of the cylinder respectively, then M — M′ will be the force that tends to contract the cylinder. If P is the air pressure introduced, then

$$M - M' = P$$

As M — M′ is constantly increasing, the pressure must be increased in the same proportion if the cylinder is to be held to a uniform diameter.

Several factors, however, affect this pressure. Among these are the following:—

1. Factors that produce or increase pressure: Air admitted under pressure through the graduating valve. Expansion due to heating the air by the hot glass in the cylinder and pot. Expansion of water vapour in suspension.

2. Factors that reduce pressure: Elongation of the cylinder. Cooling of heated air currents that rise through the cylinder. Lowering of average temperature of the air contained in the cylinder.

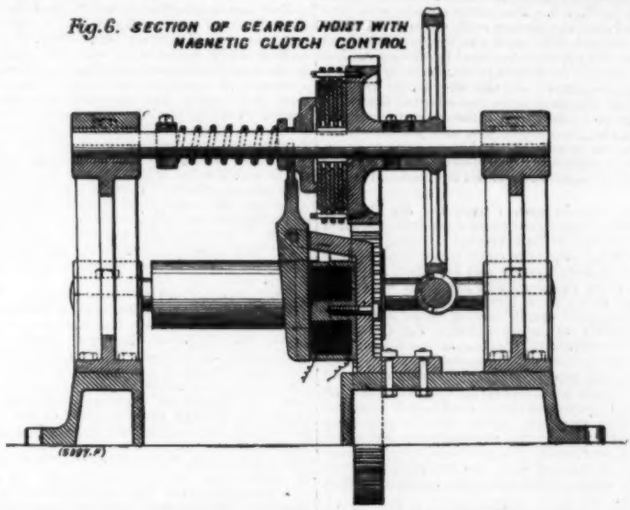
It will be seen that here are several opposing factors, and factors impossible to control, especially when we consider that the average pressure maintained in the cylinder during the draw is not much over a quarter of an ounce. The practical effect was the formation of pulsations referred to above. Why or how the air develops this pulsating or breathing flow is not even yet understood; however, Lubbers devised a means for overcoming the trouble sufficiently to meet the requirements of practical operations. That was to introduce an excess of blowing air and then allow a portion of it to escape through a vent-hole. With the discovery of this principle Lubbers completed the devising of a system of air control that stands to-day unchanged except in perfecting and applying improved mechanical details required by the huge cylinders now being drawn.

Better Regulation of the Drawing Speed.—In the first Lubbers machine there was no variation in the speed of the crosshead that carried the blowpipe. It was not long until the practice of gathering a ball of glass on the blowpipe was abandoned, and the pipe lowered directly into the glass, and when this was done it was found necessary to vary the speeds. Three speeds were used at first—one to form the neck, one for the cap, and one for the body of the cylinder. This was later changed so as to use one speed for the neck and cap, one for the body of the cylinder, and one to thin the lower end for shearing off.

It was also observed that the glass in the pot was gradually cooling as the drawing progressed, and therefore the walls of the cylinder were gradually thickening. The speed was therefore gradually increased, the increase being adjusted so as to compensate for the increasing viscosity of the cooling glass, and thus produce a cylinder of even thickness longitudinally.

Two factors control the thickness of the glass in a cylinder, first, the viscosity of the glass—governed by its temperature, and, second, the speed of draw. The same thickness may be drawn from glass of different temperatures if the speed is regulated to compensate for the variations in viscosity. The problem is, however, complicated by the necessity of drawing glass of even thickness around the entire circumference, by the necessity of preventing excessive cooling strains, and of avoiding loss of time as far as possible. In early operations there was considerable difficulty in keeping the thickness of the product up to standard single strength, and there was quite a little loss due to the production of thin glass that could not be marketed. As the machine

Fig.6. SECTION OF GEARED HOIST WITH MAGNETIC CLUTCH CONTROL



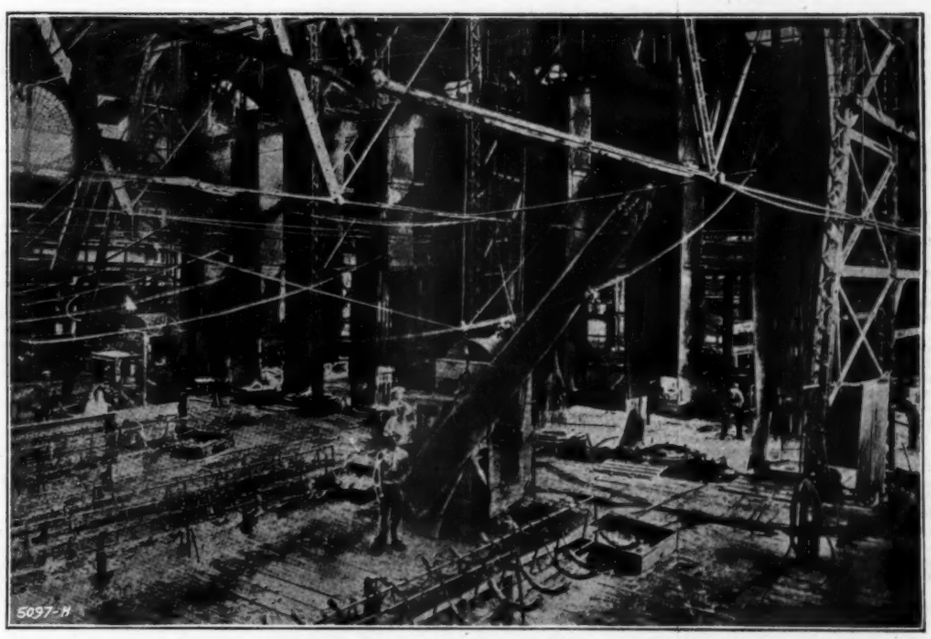


FIG. 7.

* Paper read before the Engineer Society of Western Pennsylvania.

became perfected it was not only possible to produce good, standard single-strength, but double-strength and heavier grades as well, up to $\frac{1}{8}$ in.

Several types of mechanism for raising the crosshead were tried—the one finally adopted being a motor-driven geared hoist. This was provided with a friction clutch held in position by a strong spring; an electro-magnet was used to release the clutch so that the crosshead could be lowered after the draw. This type of hoist is shown in Fig. 6. The three speeds were first provided by driving the motor with current at three voltages—15, 60 and 220—and the increase of speed during the draw was provided for, first by using a conical winding drum for the crosshead cable, later by using a series of graded resistances on the 60-volt, or drawing circuit. Finally a standard hoist was adopted that used only one voltage up to the point of thinning the cylinder to sever it from the glass in the pot, and provided with a special drum on which the cable travels over an irregular spiral so designed as to impart the necessary changes in speed of vertical travel to the crosshead carrying the pipe.

Handling the Cylinder after Completing the Draw.—In the early Lubbers apparatus there was a cord attached to the blowpipe during the draw, this cord passing through an overhead pulley. After the draw was completed the pipe with the cylinder attached was detached from the crosshead by pulling this cord and lowering, while still attached to the cord, to a horizontal position. The hoist with the magnetic clutch control made it possible to lower the cylinder by simply swinging out the lower end, using curved supports, "taking-down hooks," to support it, and slowly lowering the crosshead at the same time, on which the pipe and cylinder still remained suspended. This was hard and dangerous work for the men who handled the taking-down hooks, and considerable experimenting was done with a view to providing apparatus for taking down the cylinders mechanically. The device that was finally adopted and which is now in general use is shown in Fig. 7, and has proved a very simple and safe means of handling the heavy cylinders now being made.

This brief outline gives a very inadequate idea of the immense amount of study and research expended on the various problems involved, and the numerous alterations in the mechanical details that were found to be necessary while the machine was being developed and conditions of machine operation determined. It was a tedious and difficult task, but one by one the difficulties were overcome, until finally machine operation attained such a degree of success as to dominate the window-glass business of this country and has reached out to new fields abroad.

Lubbers' first type of machine, as has already been stated, made cylinders similar in size and workmanship to those which the single-strength hand blowers were making at that time. A present-day machine draws cylinders which are over twelve times as large, working with the precision and regularity that can only be obtained by mechanical operation.

Machine operation has immensely increased the output per tank and output per man in the blowing-room. The machine blower, operating four machines, displaces on an average eight hand blowers, and not only this, he produces a great deal more glass than the eight hand blowers could possibly make. The whole labour force of a present-day machine blowing-room is less than half the labour force in the blowing-room of a hand-operated plant. Under hand operation a tank furnace was rated as so many blowers' capacity. A 48-blower tank, for instance, was a tank designed to melt sufficient glass to supply 16 blowers on each of the three working shifts; It was estimated that if the blowers all worked to the limit of capacity fixed by union rules it was as much glass as the tank would melt. The same tanks after being remodelled—not enlarged, or only slightly enlarged—have yielded an output in finished glass that has shattered all records in hand-blown operation, and completely upset all previous ideas of tank capacity.

Not only in point of capacity, but as regards quality of product as well, has the machine secured a remarkable success. In the early operations a great deal of doubt was felt as to whether machine glass would ever equal hand-blown glass in quality. Now the standard is set by machine-made glass, which is recognised as the highest and most uniform quality produced in this country or abroad.

A wider range of thickness of glass is also produced by machine than can be made by ordinary hand blowers. Glass as thin as $\frac{1}{16}$ in. and as thick as $\frac{1}{4}$ in. is made regularly, together with all intermediate thicknesses between those limits for which there is a demand. Ordinary hand blowers make two thicknesses, single strength ($\frac{1}{16}$ in.) and double strength ($\frac{1}{8}$ in.). Not many hand blowers can make glass heavier or lighter than these standards, and because of the unusual skill required such blowers have always received extra rates for making it.

On account of the better quality and wider range of thickness of machine glass its use has been constantly extending. The bulk of the product of course continues to be used for glazing, picture framing and similar purposes. In addition, however, the lighter thicknesses are now very generally employed for photographic plates, stereopticon slides, and microscopic slides, all of which previously had been imported from Europe; none had been made in this country by hand blowing. Faces for clocks, gauges, dials, &c., are likewise largely furnished from machine glass. The heavy glass finds a wide use for automobile lamp doors and wind shields and as a substitute for plate glass.

The invention of the window-glass machine and its perfection to the present high standard of efficient operation is one of the most notable industrial achievements of recent years. It marks another triumph for Pittsburgh enterprise and skill, another example of the progressive spirit that has characterised for so many years the manufacturing operations of this district, and that has won for Pittsburgh such world-wide recognition for industrial leadership.

THE CONJOINT BOARD OF SCIENTIFIC SOCIETIES.

THE fourth meeting of the Conjoint Board of Scientific Societies was held at the Royal Society on June 13, Sir Joseph J. Thomson, O.M., Pres. R.S., in the chair, to receive the report of the executive committee on the work of the previous six months. As the report indicates, a number of important questions of scientific and industrial importance has occupied the attention of the board. Various bodies are at present interested in the formation of a census of the mineral resources of the Empire. It was agreed to enter into communication with these bodies and to make suggestions with a view to the publication of information in a form useful to the general community. Interim reports were received and approved on the necessity for an anthropological survey of the British people, on the best methods for carrying on the "International Catalogue of Scientific Literature," and on an inquiry into the desirability or otherwise of the adoption of the metric system throughout the British Isles.

The Sub-Committee on National Instruction in Technical Optics reported that a scheme approved by the Board of Education had now come into operation. Under the ægis of the Imperial College of Science and Technology an advisory and administrative committee had been formed to organise instruction, and Mr. F. J. Cheshire, a member of the sub-committee of the board, has been appointed Director of Studies in Technical Optics. Although the President of the Board of Education did not see his way to adopting the suggestions of the sub-committee, the board heard with satisfaction that a promising effort has been made to solve a question of considerable national importance.

A sub-committee, having considered special cases of magnetic disturbances revealed by a magnetic survey of the British Isles and their possible connection with the occurrence of iron ores, recommended a detailed investigation of two test areas, in order to ascertain how far, under the conditions of the British iron ores, the magnetic survey was likely to prove of economic value. Arrangements for carrying out the investigation are in progress.

An agricultural sub-committee, with the Earl of Portsmouth as chairman, reported that it is at present devoting itself mainly to engineering questions. It is engaged in collecting information with regard to the transport of raw materials to farms and agricultural products from them, to the power required for this purpose, and for seasonal operations on the land, with a view to comparing the relative advantages and costs of steam or internal combustion engines and electrically operated machines. It is dealing also with the possibility of co-operation in repairs and skilled labour, and is considering the various types of tractor most suitable to large and chiefly arable farms and to moderate-sized mixed farms, having regard to the different local circumstances and requirements.

A sub-committee was nominated to report on what is at present being done to ascertain the amount and distribution of water power in the British Empire. A complete report of the first year's work of the board will be published in due course.

A BRITISH-BUILT and BRITISH-FINANCED MAGNETO.—Under the style and title of the British Lighting and Ignition Company, Limited, a company has been formed to manufacture, in England, magnetos of the very highest grade. The fact that Messrs. Vickers, Limited, have been responsible for its inception and hold the whole of the share capital is a distinctly encouraging sign. Under such auspices one feels certain that the productions of the new company cannot fail to be fully equal to the best magnetos that have yet been constructed, whether English or foreign, and that the day of our dependence for magnetos on the alien is now over. The name chosen for the magnetos is the "B.L.I.C.," from the initials of the company. The works of the new company are in full swing, and hundreds of magnetos are being turned out weekly, to meet the requirements of the authorities; all possible preparations are being made with a view to coping with the tremendous demand that is certain to arise after the war. The offices and show-rooms of the company are at 204, Tottenham Court-road, London, W. 1.

DIESEL ENGINE USERS' ASSOCIATION.—The meeting of this association in May was held at the head offices of the Chelsea Electricity Supply Company, Limited. A paper on "Tar Oil Fuel and Diesel Engines" was read by Mr. Geoffrey Porter, A.M.I.C.E., president of the association, in which he dealt at length with the question of tar oil specifications and the quality of the oils offered by distillers, and further with facts observed and inferences to be drawn from actual experience. In view of the present high prices ruling for imported residual petroleum oils, which have until lately almost exclusively been used in this country as fuel for Diesel engines, and of the increasing difficulty of obtaining sufficient supplies of this class of oils in present circumstances, the problem of the successful use of tar oils produced at home is not only of the greatest interest to users of Diesel engines, but is of national importance as well. Mr. Porter's statement of the experience gained up to the present in connection with this class of fuel will be of great assistance to many users and prospective users, and the discussion on the subject which is to take place at the next meeting should be of very considerable interest.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—There is considerable uncertainty, not to mention uneasiness, prevailing in the South Yorkshire district as to the intentions of the Coal Controller. It is felt that some drastic intervention is imminent, and this has had a rather depressing effect upon the general situation. There is practically no alteration in the position so far as the demand is concerned, but collieries, depots and merchants are more perturbed about probable action in the direction indicated above. The local inquiry for best steams continues to be very large for inland consumption, and there is also a fair, but somewhat restricted, business passing for shipping purposes. The two combined tend to keep hard coal pits at their maximum pressure. Cobbles and nuts are going away very freely, and more could be disposed of if they were only coming to hand. There is little of these classes to be had on the open market. Many works contracts expire at the end of the present month, but there is not a ready disposition on the part of the colliery companies to arrange new ones, though in cases these have been done, with only minor concessions being obtained. Gas companies seem to be getting sufficient tonnage nowadays to place some aside for stocking purposes. They are also faring favourably in the renewal of their contracts. Slacks meet a good demand, especially from Lancashire. The house coal market is very strong, with the superior grades the most sought after. Great difficulty is experienced in fulfilling all requirements, but no reasonable orders are being refused, provided there is not a time limit attached. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at the pit.

Iron and Steel.—Though the demand for steel shows no immediate signs of becoming easier, there is quite a pronounced difference in the requirements of certain departments. Shell steel is distinctly in less request than at almost any time during the past 18 months, but this falling-off is more than accounted for by the output for other work. Marine production takes precedence, and the quantity required is on a mammoth scale. The orders for castings and forgings and other mercantile work has now reached its highest figure during the period of the war, and there are few steel houses and engineering shops which are not to-day making a very solid and substantial contribution towards assisting in the speeding-up of merchant tonnage. It may be taken as an indication of the needs of the future that at this seemingly eleventh hour new works are being rushed up and new furnaces erected. Work in plenty seems to come the way of the Sheffield firms. All departments of the iron trade are busy. The activity in the steel and engineering trades produces corresponding briskness in the heavy foundries. The output of bar iron is only on a restricted scale. It is now estimated that the output of farm and garden tools has been on a very satisfactory level, especially having regard to the depleted staffs with which manufacturers have had to work. The output of the more important implements and intricate machinery has also been quite good. Cutlery works are engaged on extensive Government contracts, and have little material for the ordinary trade. Plate makers seem to be very much at a loss as to what is going to be their position with regard to the necessary raw material. The proposed scheme for distributing the cupro-nickel scrap to the electro-plate trade has not yet assumed tangible shape, and in the meantime large orders, both from home and Colonial customers, are having to be put on one side. The general level of overseas trade is well maintained.

John Brown and Co.—Since these notes were last written Messrs. John Brown and Co., Limited, of Sheffield and Clydebank, have issued a circular to the shareholders as follows": "Owing to the continuance of the war conditions it is not found possible to present the balance-sheet to the shareholders at the usual time this month. The audit is, however, so far advanced as to assure the directors being able to pay a further amount of dividend, making, with the amount paid in December last, the same rate of dividend on the ordinary shares of the company for the year ended March 31 as for the previous year, viz., 12½ per cent., less tax." It is added that this dividend will be paid on the 30th inst.

William Cooke and Co.—Having had a successful year the directors of Messrs. William Cooke and Co., Limited, steel manufacturers, of Sheffield, have decided that, although a balance-sheet cannot be prepared as yet owing to negotiations proceeding with regard to the Finance Act and munitions levy, they are in a position to pay a dividend of 10 per cent. for the year, free of tax, on the ordinary shares.

CITY OF BIRMINGHAM ELECTRIC SUPPLY.—The statement of accounts recently issued by the City of Birmingham Electric Supply Department contains interesting figures. For the year ended on March 31, 1917, the units sold were 121,226,954 for lighting and power and 28,497,683 for traction. The corresponding totals for the preceding years were as follow:—1916, 89,712,598 and 27,303,723; 1915, 88,722,608 and 24,186,574; 1914, 49,726,605 and 24,040,573; 1913, 42,197,153 and 21,053,339. Whilst the consumption of current for traction during the last five years has remained practically stationary, the very large increase in that for lighting and power points to a considerable increase in the industrial activity of Birmingham.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—It is no exaggeration to say that in every establishment doing Government work an added spurt has been put on since the statement that the fair holidays would take place at the usual time was made. This means that less than one month now remains in which to clear off all the work in hand and the accumulated arrears, so that the pressure is most intense owing to the constant demand for steel for Army and Navy requirements. Shell bars are still needed, and the claims of the shipyards are pressing. Directly or indirectly every ton manufactured is absorbed on Government account, or is being shipped to France and Italy. No change in prices has taken place, these remaining firm.

Sulphate of Ammonia.—Arrangements have just been made with the manufacturers of sulphate of ammonia fixing the prices for the ensuing year, by which means a saving of 1*l.* per ton is offered to customers placing their orders prior to September 30. The price for quantities of not less than 2 tons will be 15*l.* 7*s.* 6*d.* per ton for the period from June 1 to September 30: from then till the end of December the price will be 15*l.* 15*s.*; and then till May 31, 1918, 16*l.* 7*s.* 6*d.* per ton will be the rate.

Malleable Iron Trade.—In the malleable iron trade the ceaseless activity is maintained at an exceptionally high level, the keen demand for delivery in no way helping to ease matters. The continued shortage of raw material has created a distinct scarcity of iron, but as, whenever possible, shell-discard steel is being used as a substitute, the pressure is being relieved to a certain extent, and consumers can be assured of more prompt delivery. Government is still on the market as a heavy buyer, practically the entire output being at its disposal, and the rolling mills are as fully occupied as is possible. Prices are good, and much on the same levels as have ruled now for some weeks.

Scotch Pig-Iron Trade.—So long as work at the steel works proceeds on the lines to which makers have now become accustomed, just so long will the busy condition of the pig-iron trade remain at its present high level. The production of every grade goes on apace, with the demand as insistent as it has been at any period since the outbreak of war. Government restrictions prevent any overseas trade in the meantime, but stocks do not accumulate. Hematite continues in heavy demand, in many instances going hot to the steel works. Firm rates are still quoted.

Clearance Certificates.—The announcement that certain changes are anticipated in connection with clearance certificates has been received with much satisfaction in industrial circles in the Clyde area, and although some restrictions may still be enforced on men transferring their services from Government to private work, in the main the abolition of the clearance certificate system as now existing under the Munitions Act should have good results. Consisting of a Sheriff and two lay members, one representative of the masters, the other of the men, the local Munitions Tribunal sits in Glasgow, but deals with all cases in the West and South-West of Scotland. This tribunal is supposed to sit four days a week, but daily sittings are more common, two, three or more hours being occupied with the cases to be considered, the principal business being the hearing of evidence regarding the desirability or otherwise of granting clearance certificates to workmen who wish to be released from the employment upon which they are engaged. It is affirmed that much valuable time might be saved, both to employers and employed, if this system were entirely done away with, while the services of the members of the tribunal might well be directed into more profitable channels.

Fair Holidays.—Glasgow Fair is from July 13 to July 25. Falkirk starts the holiday on June 29 and ends it July 9. Greenock Fair begins on July 6 and ends on July 16. Edinburgh, Dundee and Aberdeen make holiday between July 20 and 30. Other places intervene, and Paisley finishes the series on August 20. Attempts are being made to furnish facilities for travel, but these will be less than in previous years, and the munition workers will be well advised to explore the beauty spots near home, which, in former years, they have neglected in their desire to go far afield. There is a certain satisfaction in taking a holiday at a distance; it seems, somehow, to break more effectually the connection with work. But this year other considerations supervene, and the patriotic citizen will be content with a shorter journey and more time for recreation.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The market, so far as Cleveland pig-iron is concerned, shows no material change since our last report. Values are well maintained, but business is only quiet, home transactions being practically suspended for the time being, pending the issue of the July allocations. In the meantime ample deliveries are proceeding satisfactorily under the June allotments, and with iron plentiful there is rather more passing on foreign account. Shipments show improvement, and if tonnage were available exports would be heavy, as there is no difficulty now in securing licences for dispatch to certain continental ports. Many producers have rather considerable stocks of forge iron, and are willing to sell that quality at rather below recognised price. Certain efforts to encourage the use of forge iron in place of better descriptions have met with a good deal of success, especially in Scotland, to which country large and increasing supplies have been going, but with the approach of the July holidays in Scotland dispatches to consumers north of the Tweed threaten to be curtailed. Scandinavia would readily purchase forge iron, but embargo prevents dispatch to that quarter. Our Allies are receiving fair quantities of foundry iron, but the volume of shipment depends on tonnage available. For home consumption No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge all stand at 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; and for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.* The stock of Cleveland pig-iron in the public warrant stores still stands at 1,365 tons, all of which is No. 3 quality, no change having been recorded since the 11th inst.

Hematite Iron.—So far as East Coast hematite iron is concerned new business is still almost entirely confined to transactions on home account, sellers showing as much reluctance as ever to book foreign orders on the terms obtainable. Supply continues sufficient to meet all legitimate home needs, and to leave some surplus for shipment abroad against contracts made some little time ago. A few negotiations with a view to fixing further contracts for home supply are reported, and there are applications concerning sales to Italy and France; whilst rather substantial exports are proceeding under old contracts, many of which are considerably in arrears. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 142*s.* 6*d.* for export to Italy.

Manufactured Iron and Steel.—No new development of moment is noticeable in the various branches of the finished iron and steel industries. Government needs and the demands of the shipyards keep manufacturers working at very high pressure, and so absorb the output that little opportunity indeed is afforded to put through ordinary commercial business. Prices are very firm. To home customers the following are among the principal market quotations:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

Coke.—Values of coke are well maintained, though supply is more than ample. Descriptions needed for the local blast-furnaces continue in good demand, and still realise fixed maximum rates, average sorts selling at 28*s.* at the ovens, and low phosphorus qualities at 30*s.* 6*d.* at the ovens.

ROYAL ORDNANCE FACTORIES TRADE LADS.—On Saturday evening, June 16, a meeting of past and present trade lads was held at Woolwich Polytechnic to consider the proposed association for trade lads and ex-trade lads. The principal of the Polytechnic, Mr. A. F. Hogg, M.A., F.C.S., was in the chair. In his opening remarks he pointed out the advisability for the formation of such an association, and explained how beneficial it would be to young trade lads, in bringing them together for social evenings, meetings, &c.; besides enabling them to form clubs for various branches of sport. There are many Royal Ordnance Factories trade lads who have achieved distinction, and among them may be quoted Sir Croydon Marks and Mr. G. F. Banister. The hon. secretary, Mr. R. Such, 55, Ancona-road, Plumstead, S.E. 18, will be pleased if any ex-trade lad wishing to join the association will communicate with him.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—A meeting of the Manchester branch of this association was held in the large Y.M.C.A. Hall, Peter-street, at 3.30 p.m., on Saturday, June 9; about 500 members were present, this being the first general meeting since the formation of this branch. The chairman pointed out the need of organisation and introduced the various speakers, amongst whom was Mr. Blair, the general secretary from the Glasgow Executive Committee. The chairman of the technical section then explained what was intended to be done for the improvement of education and the minds of the members and draughtsmen generally. It was proposed to further this object by three courses: (1) By visits to engineering works, (2) by forming a technical library, (3) by giving lectures and holding discussions. Mr. Blair then spoke as to what had been done by the association to obtain Government and technical recognition of the claims and position of the draughtsmen. The coming amendment of the Munition of War Acts in favour of draughtsmen was also hinted at and the raising of the living standard of the profession was agreed to. The speaker said it was proposed in future to admit only fully qualified draughtsmen to membership of this association. They would have to be proposed and seconded by members and duly pass an entrance examination, yet to be arranged, before admittance, as this was already done by some of the other engineering societies. He also pointed out the help this association had already given to the Government in advising certain departments for the prosecution of the war. The secretary of the branch then gave some figures as to the progress of the movement, and stated that 12 districts were now included in the Manchester area within a 15-mile radius of the city, with a membership of over 1,000, whilst in January of this year there were only 300 to 400.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Depressed conditions have characterised the coal market, and for spot positions prices for all classes of coal have been easy. The supply of requisitioned tonnage is not far below the normal, and only comparatively few tips have been idle in the local docks. The difficulties over the compensation terms and the application of the new fixed prices are also disturbing factors, and fears are expressed as to future prospects unless steps are taken without much further delay to make it clear to the colliery owners where they really stand in regard to prices and profits. No improvement is noticeable in the situation so far, and reports were current about the middle of this week that colliery companies were finding it difficult to keep the pits working owing to scarcity of empties. Under the circumstances current quotations possess only a nominal interest, the values at which coals are actually changing hands being determined after individual bargaining. Smalls are still the weakest spot in the market, and stocks are extremely heavy. Coke is also weak, and obtainable at figures appreciably below the limitation price.

Newport.—The greater proportion of the outputs of the Western Valley and Eastern Valley collieries are still being absorbed under Government and allied contracts, but the quantity of floating supplies is increasing, and prices for prompt shipment are showing greater weakness. There were a number of pits reported idle on Wednesday through want of empties. Prices are ruling nominally up to 29*s.* for Black Veins, and up to 28*s.* for the best Eastern Valleys. The business done, however, is almost negligible.

Imported Pitwood.—The Bristol Channel Pitwood Importers' Association has just been considering the scheme suggested by the Deputy Controller of Import Restrictions. Under the scheme, which has reference to France and Portugal, importers, other than those supplying the Admiralty collieries, will be allocated three-eighths of the imported pitwood. The allocation will be based on the average quantities imported during 1914 and 1915. A general licence is given to the committee formed for carrying the scheme into effect, and this committee will issue licences to the individual importers on the basis indicated. It was, however, with reluctance that the members of the association accepted the scheme. It was, therefore, decided to enter a strong protest against the allocation of a proportion of only three-eighths to importers other than the firms which have, since the outbreak of the war, been engaged as the agents for the supply of timber to the Admiralty collieries, who are now to receive the remaining five-eighths. The ground of the protest was that prior to the war the importers who are now only to receive three-eighths of the trade imported two-thirds of the total quantity of foreign pit timber brought annually to the Bristol Channel ports.

State Control of Mines.—The terms relating to the financial conditions under which the collieries will be controlled by the State during the period of the war have not yet been officially disclosed, and until the official embargo is removed it is not permissible to publish them. It is, however, becoming more generally known what these arrangements are, and on Tuesday there was a record attendance of members at the meeting of the Monmouthshire and South Wales Coalowners' Association, which was specially convened to deal with the matter. The proceedings, too, were of an exceptionally protracted character. For the reason indicated the proceedings were absolutely private, but it may be stated that as a result a deputation was appointed to wait upon the Controller of Mines in order to lay before him some of the points raised by the members. It is no secret that there prevails a good deal of anxiety in coal trade circles as to what may be the ultimate arrangements.

PERSONAL.—The Morgan Crucible Company, Limited, announce that they have entered into an agreement with Messrs. John Wright and Co. (John Wright and Eagle Range, Limited), of Essex Works, Birmingham, whereby the interests of the two companies in regard to crucible furnace manufacture and supply will be mutual. The well-known types of Morgan's patent tilting furnaces and "lift-out" furnaces will be manufactured in future for the Morgan Crucible Company, Limited, by Messrs. John Wright and Co. It is intended that the best types and patterns of both companies be supplied, and these, together with all new joint designs, will be known as "Wright-Morgan furnaces." Upwards of 3,000 tons of brass per week have been cast in Morgan's patent tilting furnace plants erected since the outbreak of war. By entering into this agreement with Messrs. John Wright and Co. for the manufacture of melting furnaces the construction of the latter will be concentrated in Birmingham, and the Morgan Crucible Company will be free to absorb the valuable space hitherto occupied for furnace work into its crucible-making departments.—The Morgan Crucible Company, Limited, also announce that the recent fire at their Battersea works, which caused slight damage to an isolated building of the crucible factory, will only affect the delivery of a few special sizes of crucibles for a few weeks: the production and delivery of morganite and Battersea carbon brushes are in no way affected.—Mr. J. S. Highfield has removed his office to 36, Victoria-street, S.W. 1. He continues his connection with the Metropolitan Electric Supply Company, Limited, as consulting engineer.—Messrs. Couzens and Brown, consulting engineers, of 50, Queen Anne's Gate, Westminster, S.W. 1, are removing to 9, Old Queen-street, Queen Anne's Gate, Westminster, S.W. 1, which will be their address on and after the 24th inst.

LIGHT DUTY TWO-MOTOR TRAVELLING HAMMER-HEAD JIB CRANE.

CONSTRUCTED BY MESSRS. ROYCE, LIMITED, ENGINEERS, MANCHESTER.

FIG. 1.

WE illustrate on this page two examples of a useful type of crane for light machine shops, &c., and now in extensive employment in munition and other factories. The cranes run on tracks laid in the shop floor, the tops being flush with the floor. They are designed for a maximum load of 10 cwt. at a maximum radius of 10 ft., or alternatively a load of 6 cwt. at 16 ft., when working on rails at 4ft. centres. While hoisting and travelling are effected by electric power, slewing is done by hand. The supply of current may be brought to the crane by means of a conduit between the track rails, and Fig. 1 illustrates such a type, or may be supplied from overhead bare conductors on the trolley system, as illustrated in Fig. 2. There are separate electric motors for hoisting and for travelling, the power of the former being 1 brake horse-power and of the latter 3 brake horse-power. In the case of the 10 cwt. 10-ft. radius crane the hoisting speed is 20 ft. per minute with the maximum load, while with the 6 cwt. 16-ft. radius crane the maximum load is lifted at 30 ft. per minute; in each case double the speed is attainable with a light load. The traversing speed is in each case from 200 to 220 ft. per minute. The load is lifted on a single fall of special flexible steel wire rope, fitted with a suitable hook on a ball swivel bearing. The rotating jib and pillar of the crane, which, it will be seen, is of neat design, works in a cast-iron base, which constitutes the travelling truck of the crane, being fitted with four travelling wheels of cast steel, turned on the tread and keyed on to steel axles, which revolve in easily renewable gun-metal bush bearings in the base. Both axles are positively driven, being connected by a Renold bushed roller chain. All the gears are machine-cut from the solid and all pinions are of steel. Mounted on a steel frame on the cast-iron base are the resistances and controllers, which are of the tramway type, and there is also a main D.P. switch and fuses for each motor. Platform and seat are provided for the driver, as shown, within easy reach of the controller and switch handles. Guards are provided around the slewing collector rings and around all the live parts. Guard bars are also arranged around the travelling wheels. The manufacturers are Messrs. Royce, Limited, Trafford Park, Manchester.

FIG. 2.

EXTENSION OF THE WORKS OF THE TOTTENHAM LIGHT, HEAT AND POWER COMPANY.

MR. A. E. BROADBERRY, M. INST. C.E., CHIEF ENGINEER.

(*For Description, see Page* 585.)

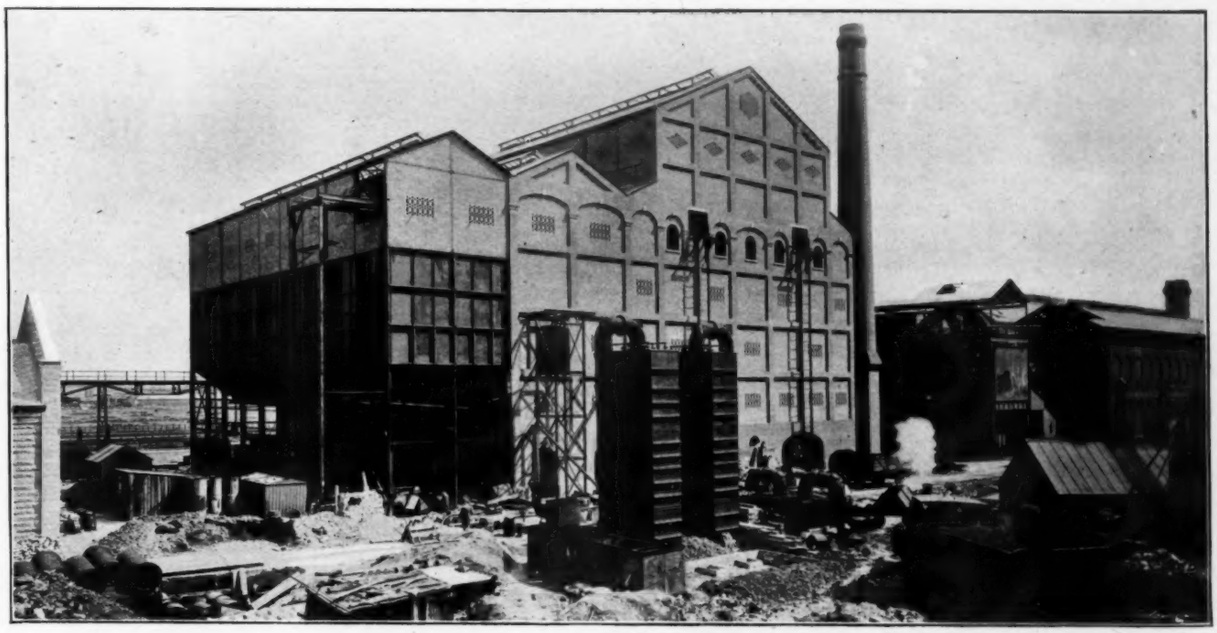


FIG. 5. NEW RETORT HOUSE.

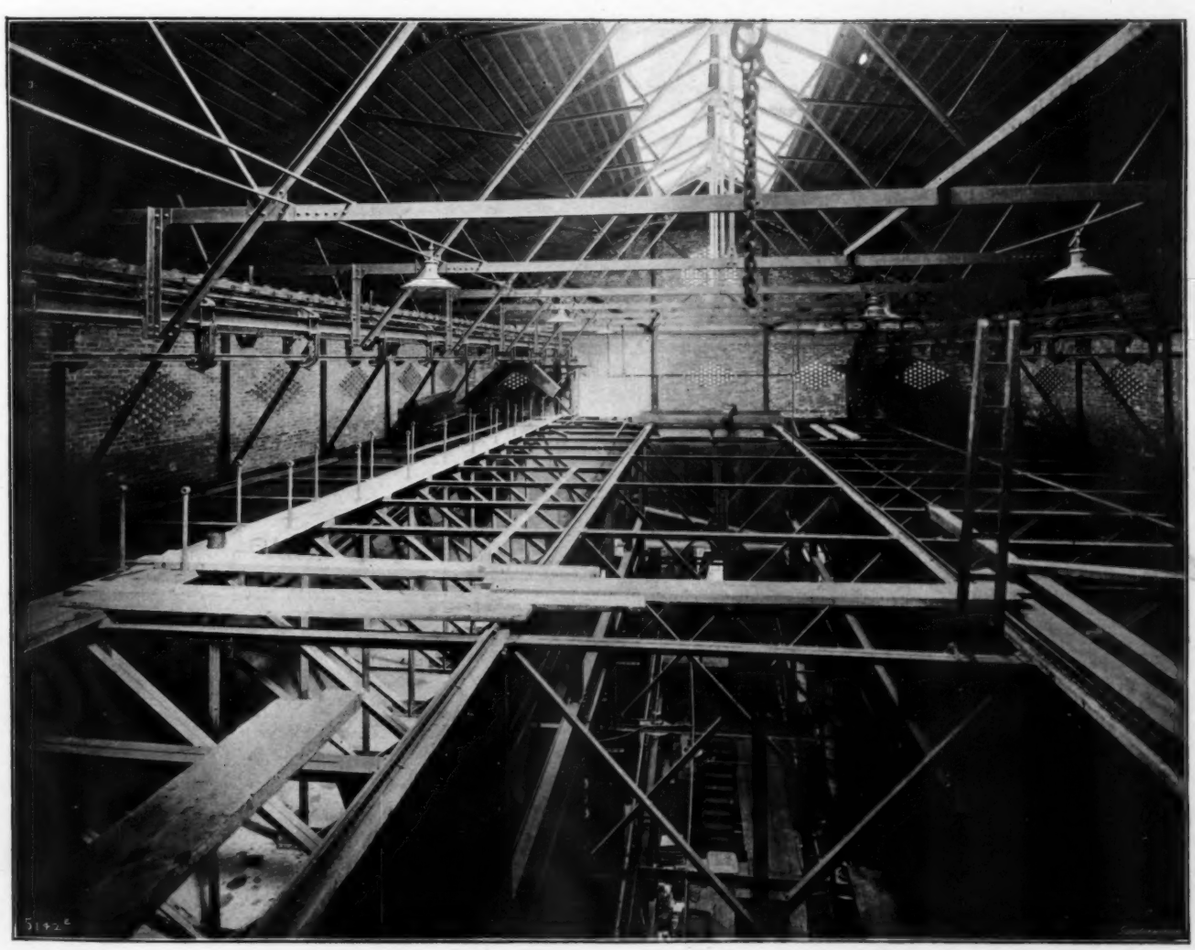


FIG. 6. COAL BUNKERS IN NEW RETORT HOUSE.

(*To face page* 586.)

EXTENSION OF THE WORKS OF THE TOTTENHAM LIGHT, HEAT AND POWER COMPANY.

MR. A. E. BROADBERRY, M. INST. C.E., CHIEF ENGINEER.

(*For Description, see Page* 585.)

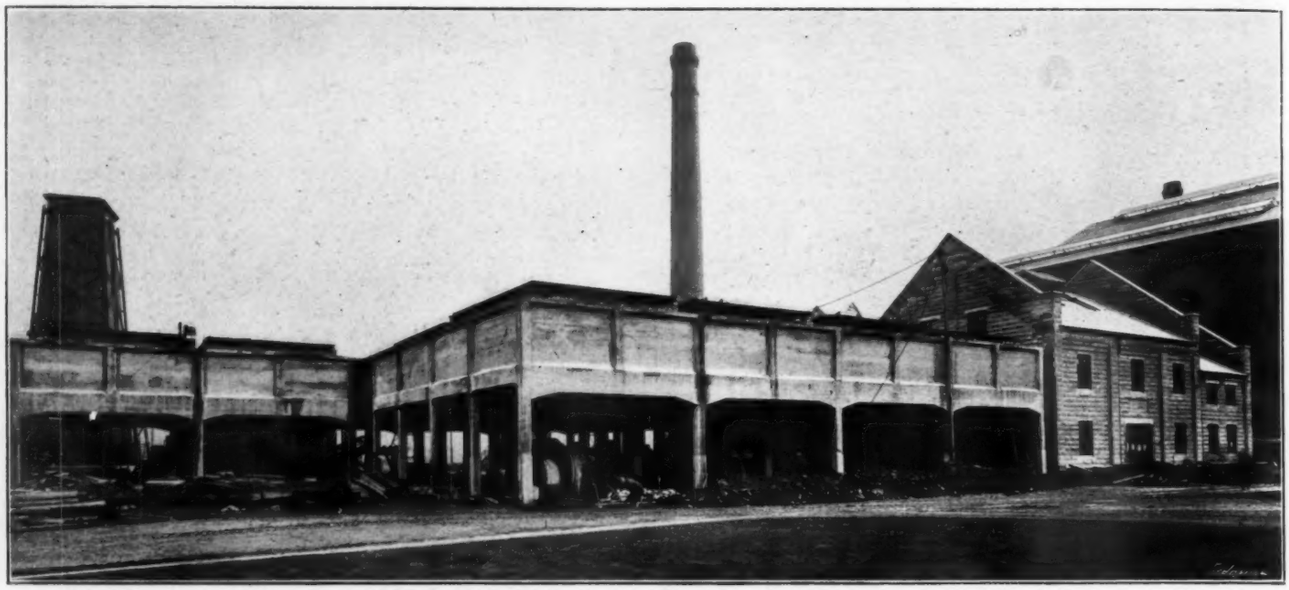


FIG. 7. REINFORCED CONCRETE PURIFIERS.

FIG. 8. PURIFIERS IN COURSE OF CONSTRUCTION.

EXTENSION OF THE WORKS OF THE TOTTENHAM LIGHT, HEAT AND POWER COMPANY.

MR. A. E. BROADBERRY, M. INST. C.E., CHIEF ENGINEER.

(*For Description, see Page* 585.)

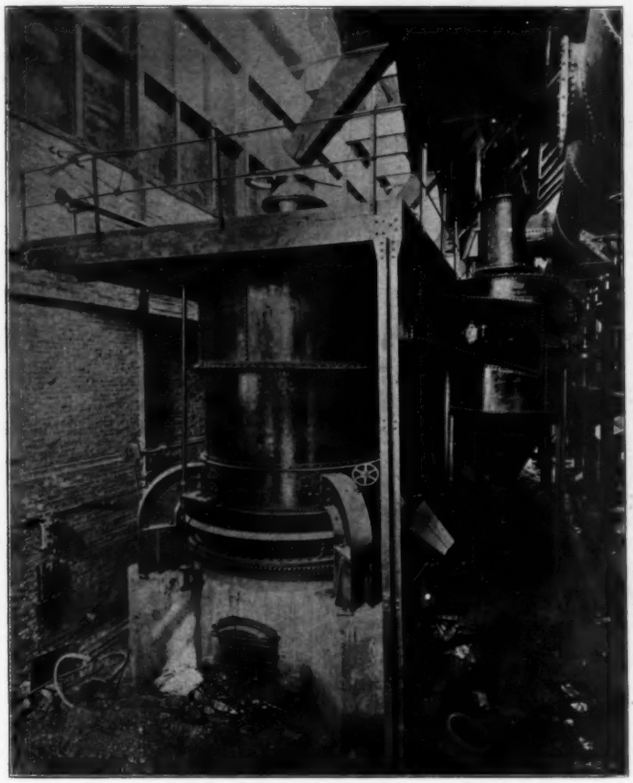


FIG. 9. OUTSIDE GAS PRODUCERS.

FIG. 10. VIEW OF TOP OF COKE BUNKERS FOR GAS PRODUCERS.

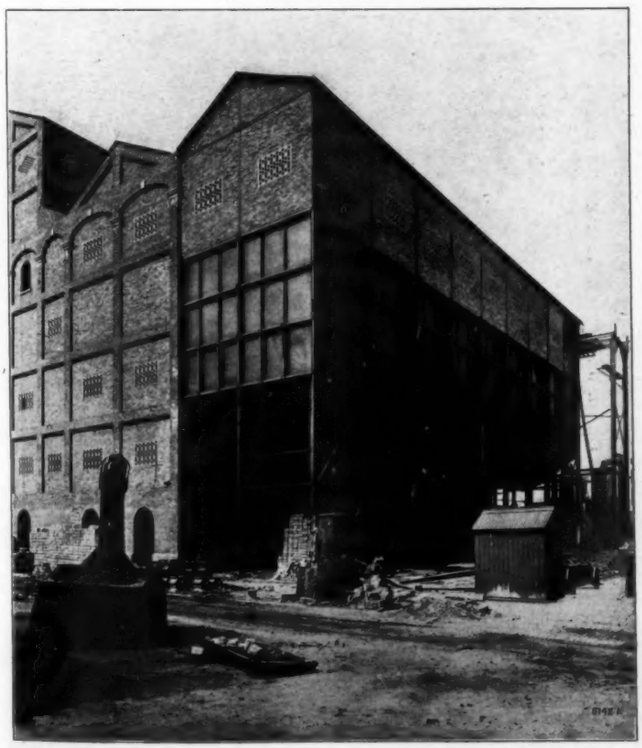


FIG. 11. MAIN COKE HOPPERS.

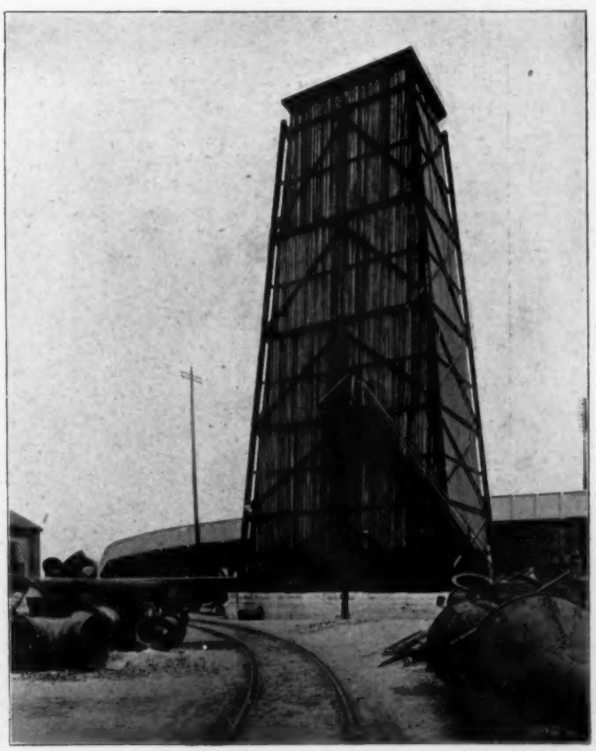


FIG. 12. COOLING TOWER.

EXTENSION OF THE WORKS OF THE TOTTENHAM LIGHT, HEAT AND POWER COMPANY.

MR. A. E. BROADBERRY, M. INST. C.E., CHIEF ENGINEER.

(*For Description, see Page* 585.)

FIG. 13. CHARGING STAGE FOR VERTICAL RETORTS.

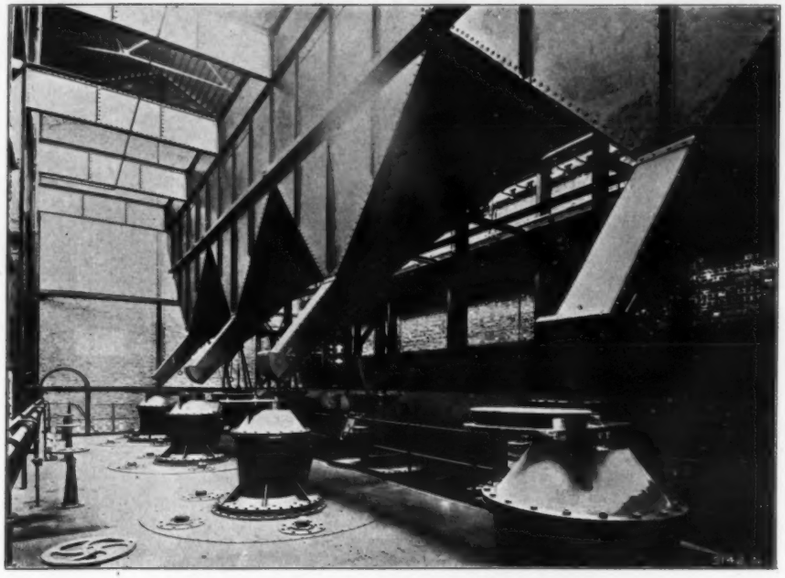


FIG. 14. CHARGING STAGE FOR GAS PRODUCERS.

FIG. 15. COAL TIPPERS.

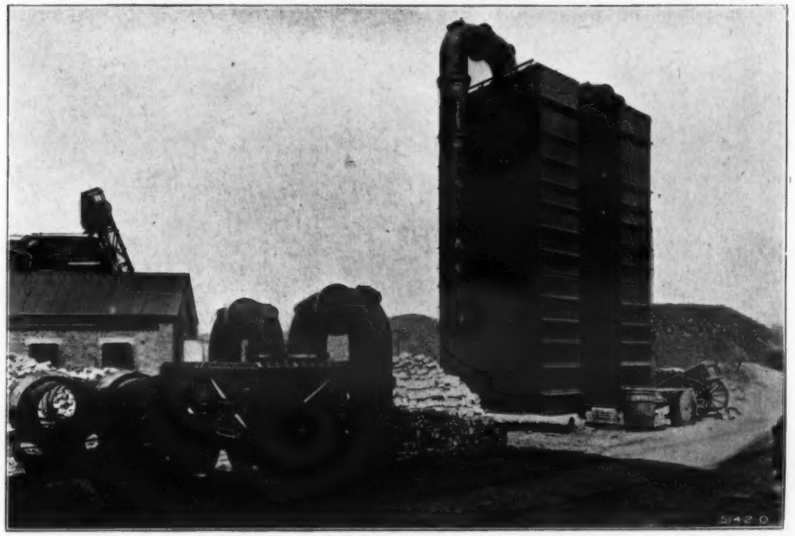


FIG. 16. CONDENSERS AND HOT WASHERS.

(*To face page* 587.)

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The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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NOTICES OF MEETINGS.

THE PHYSICAL SOCIETY OF LONDON.—Friday, June 22, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W. Agenda:—(1) "The Determination of Coma from a Central Ray," by Mr. T. Smith, B.A. (2) "Chromatic Parallax and its Influence on Optical Measurements," by Mr. J. Guild, A.R.C.S., D.I.C., F.R.A.S. It is hoped also to have some optical demonstrations by Mr. S. D. Chalmers and possibly others.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Thursday, Friday and Saturday, June 28, 29 and 30, at Hastings. Papers to be read:—"Public Abattoirs," by Mr. H. Brown, Weston-super-Mare. "Extraordinary Traffic and Excessive Weight on Highways," by Mr. H. T. Wakelam, M.Inst.C.E. "The Object and Scope of the Institution Examination," by Mr. Edward Willis. "Dry Rot, its Causes and Prevention," by Mr. E. J. Goodacre, A.M.Inst.C.E., Shrewsbury. "Municipal Works of Hastings and St. Leonards-on-Sea," by Mr. G. F. Miller, Hastings.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

ENGINEERING.

FRIDAY, JUNE 22, 1917.

THE MUNITIONS OF WAR ACT.

THE facts that call for the amendment of the Munitions of War Act have now been stated by the Minister of Munitions to the Amalgamated Society of Engineers. As far back as October of last year the Man-Power Distribution Board certified the needs of the Army for men and for munitions; and they came to the conclusion that there could be no other way of obtaining all the requisite skilled labour than by extending the principle of dilution, with appropriate safeguards, to commercial work. For reasons that he assigned Dr. Addison is convinced that, however urgent the need may have been in October, it is far more urgent now, and that it can only be met by a system under which skilled men can be taken from private and commercial work without at the same time strangling industries upon which the ordinary working life of the community depends.

It is proposed, therefore, that, with a view to obtaining the necessary skilled labour where national interest requires it, certain extensions shall be given to the use that is made of dilution and to the definition of munitions of war. Before any such extension is made the Government, if they initiate it, will consult with the trade unions and with employers; and the employer, if it is he who proposes the further dilution, must invite his employees to attend a deputation, accompanied by the local representative of their trade union, and must thereafter obtain the consent of the Minister. The restrictions imposed by the principal Act on the right to strike are not to apply to these new uses of dilution; and, while the penalties on employers who fail, after the war, to restore any trade union conditions that existed in their shops before it are to be enforced strictly, and to continue for twelve months after peace is declared, the existing provisions by which strikes and lockouts on restoration questions are prohibited during that period are to be abrogated altogether.

No doubt can be felt, as we pointed out recently, that the present practice of dilution is dangerous and unjust, not only in excluding essential industries, but also in the manner of its application within the industries to which it is applied. The present proposals may give the safeguard of dilution in the trades in which it is required, and to that extent they are welcome. But they couple it with conditions that in otherways maintain and add to the danger, injustice and insufficiency of the present system; and all engineers who are concerned with the public interest as well as with that of their own trades will trust that the wisdom of Parliament may refuse to sanction these conditions.

The essential reason of the present negotiations, disguised through it is among others that are not essential, is the claim of trade union members to be relieved of military service. A large part of what is described as skilled labour consists of men from other trades, or newly introduced into the engineering trades, whose skill begins and ends with their membership of the union, and so much as they have picked up during the war. The trade unions have taken their money, and in the narrowly sectional discussions by which the Government attacks the grave problems of industry cannot be blamed for doing their best to earn it. But the Government, if it now applies the further dilution that on its own statement has been required for the last eight months, has on it the duty of applying this dilution impartially. It is not entitled to wrong those who are not engineers, and to disgrace those who are, by using it to retain in civil life fit men of military age whose work can be done by women. Dilution, if the powers of the State are to be administered justly, must not be used merely as a means of obtaining the necessary skilled labour. It must be applied equally to releasing for military service those men who can be spared from civil life, and would be soldiers if they were not called engineers.

Leaving out of account the men who have rushed, or have been rushed, into the various unions during the war, of whose numbers all that is known publicly is that they are great, unionists form only a fraction of those who work in the engineering trades; and the proposal to force consultation with unions even on those masters and men who can regulate their affairs without them is an interference with their right to protect their own interests in their own way. From the time of its foundation the Ministry of Munitions has consistently subordinated the law that was passed for the protection of its soldiers to trade union influences, whenever these have been asserted with sufficient insistence. Their reward has been an unceasing series of strikes and the continued practice of restrictions on output; many thousands of homes know with what result. To require non-unionists to agree with the unions on further dilution is to claim from non-unionists a sacrifice that the Government is abundantly justified in taking if it means to enforce the law honestly and impartially for the purpose for which it has been made. To require it with any less intention is a merely political device, which this is not the time or place to discuss.

As much, however, cannot be said of the proposal that the further dilution, which is to provide for the increased need of munitions and to save industries essential to the nation from being strangled, should be subject to revision and control by strikes, nor to the abrogation of the moratorium after the war for strikes relating to the restoration of trade union conditions. The Government knows well that these conditions could only be restored effectively by ruining the workmen who were subject to them or who sought to enforce them; and its talk of such a restoration cannot be based on any hope or expectation that it will be made. The effect of its present proposal can only be to free the unions, if they so wish, to use methods of violence instead of reason; to leave the reconstruction of industry to be discussed as a matter of bargain between sectional interests, in which one party's hands are tied for twelve months while the other's are left free, and not in its true character of a national problem, the gravest that the nation, or indeed the imperial Commonwealth, will have to face after the war.

Whatever may be the merits of strikes as a method of industrial settlement, this is not a time when they are either necessary or permissible. Under old laws a strike was a conspiracy to do what was against the public interest; and it was made lawful because it was thought that the public interest in avoiding it was far less than the workman's interest in using it. Disastrous though strikes are to all parties in the community, there have been times when beyond question the balance of hardship was against the striker; when it was unjust to deny him this crude weapon, because he

(To face page 587.)

had no other, and without weapons was defenceless. But at the present time every one of these conditions is reversed. Before the right to strike was suspended the most ample precautions were taken to protect workmen from consequent hardship. Practically no class of worker in these trades has failed to gain in pocket during the war, except those of the widest experience and highest skill, who have continued on day-work at rates that often do not make up for the increased cost of living. We hear little of these men's grievances, and in common justice it would be well if more notice were taken of what we do hear; but if they are left out of account, as on present practice they are quite likely to be through the smallness of their numbers, workmen are better protected for the time being than they have ever been before. And while, therefore, their dependence on strikes for any essential interest is incomparably less than it was when strikes were made lawful, what has happened to the public interest in avoiding strikes? It is no longer a question of price. In the provision that has been made for protecting workmen the public has already paid, and will continue to pay, the utmost price that men could have asked. It pays this price because, short of the lives of its soldiers and the preservation of its necessary industries, its present interest is above all price. With the workmen's interest so safeguarded, and the public interest so enhanced, a strike becomes in fact the intolerable outrage on society that it was formerly in law. And it is with the extension of this outrage in the discretion of those who have negotiated these proposals that the nation and its forces are threatened.

The alternative is plain to all responsible engineers. The law that is at present administered in the interests of a privileged class must be applied impartially to all classes. So long as men in favoured trades are exempt from military duty, whether they are replaceable or indispensable, at work or on strike, they will be at the mercy of the mischievous influences that have been misleading them for the last two years. If their choice were not, as at present, between work and play, but between work and military duty, and strikers of military age and fitness were taken automatically by the recruiting sergeant, as all such men are in other trades, these influences would lose their force. Those only would go on strike who wanted to fight; and the large majority, including not only the men who joined the trade in order to avoid military service, but those who are led into strikes by mere contagion or coercion, would keep to their duty and their work. While they are so engaged they are entitled to all the safeguards that can be given them against loss and hardship; but they are not entitled to the right to shell the country's soldiers in the back, which on the highest authority has been declared to be the real consequence of a delay in production, nor to strangle the nation's necessary industries when its utmost effort is needed to preserve them. The Government has waited eight months since it knew from its own Board that the country needed men who could be obtained only by further dilution. There has been nothing in the circumstances of engineering manufacture to justify the delay in providing that dilution; and there is nothing now to extenuate the national sacrifice and the individual injustice that would arise from further delay or a continuance of the present unequal incidence of such dilution.

THE ESTIMATION OF TOLUENE IN CRUDE PETROLEUM.

SINCE the war began the public has heard a great deal about benzene and toluene and aromatic hydrocarbons. In normal times these products were chiefly wanted in the dye industry, as solvents, and as motor fuels, but the claims of the manufacturers of high explosives are now paramount, and the public must put up with a severely restricted supply of motor spirit. As raw materials for high explosives the various aromatic hydrocarbons have not equal values; but they are all needed in the many departments of the industry. The three chief aromatic hydrocarbons—the name is due to the peculiar aromatic smell of many of their derivatives—are benzene, toluene and xylene; inasmuch as benzene had a long history of varied application, and toluene is the chief raw material for the manufacture of one of the most powerful modern explosives—trinitrotoluene, the popular TNT—the term toluene now frequently serves as a general name for raw materials for explosives from that group. Benzene is C_6H_6, toluene $C_6H_5 . CH_3$, xylene $C_6H_4 (CH_3)_2$; they are all colourless liquids, of densities 0.884, 0.870, 0.865. This last figure is approximately correct for the three isomeric xylenes, the ortho-, meta- and paraxylene, which generally occur together, the meta compound predominating strongly in coal-tar. Xylene, we should say, is almost as valuable at present as toluene and costs more than twice as much as benzene. The boiling points are: benzene 80.5, toluene 110.3, and the three xylenes 141 deg., 137.8 deg., 137 deg. C.

These hydrocarbons and their higher homologues, together with the saturated hydrocarbons or paraffins of the formula C_nH_{2n+2}, the unsaturated carbons or olefines C_nH_{2n}, are found in natural petroleum; but the aromatics often do not make up 1 per cent. of the crude oil. American petroleum is very poor in toluene, but richer in higher aromatics, especially when asphaltic; Trinidad oil may contain several per cent. of toluene and more of xylene and the higher homologues. As a rule the direct distillation of the crude oils for toluene would not pay, in spite of the above-mentioned differences in boiling-points, even if there were no paraffins, &c., present of almost the same boiling-points, and if the aromatics had not the unfortunate tendency of forming mixtures with other hydrocarbons, alcohols, &c., which pass over as such when heated at temperatures far below the real boiling-points. Hence the desire to raise the percentage of toluene by cracking. But all cracking processes are wasteful; a large bulk of a useful oil is turned into carbon, methane, hydrogen and unsaturated hydrocarbons, all inferior in value to the main product aimed at. There is doubt, moreover, as to the percentage of toluene actually gained by cracking; the analyses are difficult, and reliance is often placed on indirect estimates. Attention is therefore once more drawn to the direct isolation of toluene from the crude oil or spirit. Such processes would have the great advantage that they would not—or should not—impair the remaining oil. On account of the presence of the paraffins in the original oil, however, the analytical difficulties are, in some respects, even greater than with cracked oil. Before risking novel processes, moreover, manufacturers want to have precise information on the percentage of toluene that might be extracted from crude oils and petroleum spirits. It was with these analytical problems that Mr. S. E. Bowrey, B.Sc., London, dealt in an able paper on "The Estimation of Toluene in Crude Petroleum," brought before the Institution of Petroleum Technologists on Tuesday the 15th ult. The paper was almost purely chemical; but an outline may be of interest. Mr. Bowrey exhibited some remarkably neat, novel apparatus which he has worked out in the course of his research in the laboratories of Messrs. A. Duckham and Co., with the assistance of Miss E. M. Thomas.

When a crude oil is examined, everything that will boil away above 150 deg. C. (about) is, as a rule, first removed by distillation. Then follows treatment with sulphuric acid and washing with alkali and water; the acid binds the unsaturated hydrocarbons, but not the others. The specific gravity of the residue generally affords useful information. Often, however, sulphonation has to follow, treatment with concentrated and then with fuming sulphuric acid, which attack only the aromatic compounds, or nitration (treatment with nitro-sulphuric acid), and further various selective solvents are used, among which Edeleanu's method (liquid sulphur dioxide) stands foremost. Mr. Bowrey's method is an improvement of that of Edeleanu, who first proposed it for the raffination of lamp oil, not for the laboratory. None of these reagents are very pleasant to deal with. Mr. Bowrey hence tried, first of all, also the apparently simplest method of splitting the petroleum, by careful re-distillation, into separate fractions for benzene, toluene and xylene. That this is possible was stated by Dr. A. E. Dunstan, who, following Professor Brame, made a valuable contribution to the discussion; but he had to apply six redistillations. In general, the already-mentioned tendency of the aromatic hydrocarbons to form with paraffin mixtures of constant boiling-points interferes too much; these difficulties, Mr. Bowrey stated, had been experienced also in a 10-ton plant in Trinidad. We will say a few words about these different methods.

Density determinations should be helpful, because the paraffins are lighter than the aromatics and the naphthenes; but the aromatics themselves differ little in density, whilst the paraffins differ considerably, so that the method is promising only when relative significant percentages of aromatics are present, and there is a complication, because it is not certain that the various constituents really mix, as is assumed, without change of volume. Nitration may go further than intended, and lead to a general oxidation, and as mono-, di- and tri- products may be formed, the calculations are not easy; as regards sulphonation, the quantitative recovery of the sulphonic acids (by hydrolysis) is impracticable. These reasons explain the preference for selective solvents of less violent type than those acids. Such are alcohols, acetone, aniline and sulphur dioxide; all these dissolve the aromatics rather than the paraffin and naphthene. Dr. Mollwo Perkin remarked that he had tried dimethyl sulphate before the sulphur dioxide was introduced; it had the advantage that it could be used at ordinary temperatures, but it was very poisonous; that, however, seems to be an individual question, since Dr. Dunstan had not been troubled by the poisonous character of this compound.

The liquid sulphur dioxide SO_2 is, of course, a refrigerating agent, and one of Mr. Bowrey's improvements, as we shall see, consists in the utilisation of this property, instead of placing the liquid in a vessel cooled by ice and salt. Thus he was able to work at — 35 deg. C. (instead of — 12 deg.) and to increase the percentage of aromatics (he mostly experimented with mixtures of the three in equal proportions) extracted from paraffin (85 per cent.) mixtures considerably. He extracted first in a Dewar vessel, joined to a pump so that distillation took place in a vacuum; more benzene than xylene is extracted, as might be expected; but as some paraffins are also volatilised, some correction has to be applied. Dr. Dunstan subsequently pointed out that as the process really depends upon differences in solubility and volatility, a careful study of temperature influences is required. Mr. Bowrey's improved apparatus, which was much praised both for its ingenious design and as a fine piece of glass-blowing, consists of a three-walled Dewar flask joined to a pump and thereby to a distilling flask, in which the extract is freed from the SO_2 by heating over a gas flame, whilst the pump and a separating funnel had been used in his first apparatus. The inner jacket of the Dewar flask is charged with liquid SO_2 to keep the liquid inside cold.

The chief novelty, however, is the automatic temperature regulator of the Reichert type which he has added to his distillation apparatus. It is a rather complicated device. The quantity of extract obtained is generally small, and the fractionation of the isolated hydrocarbons (into benzene, toluene and xylene) has to be slow, at the rate of about six drops per minute. An apparatus for this purpose would require very careful watching; the apparatus Mr. Bowrey has designed can be left to itself. In the stopper of the flask is fixed a dephlegmator, a vertical glass tube or column loosely packed with copper turnings and surrounded by a jacket in which SO_2 is circulating under reduced, adjustable pressure. The vapour leaves the column above through a pin-hole aperture, and the vapour pressure in the column is kept constant by the action of a mercury cut-off. This device consists of a short U-tube filled with mercury and sealed into the column below the pin-hole. When the vapour pressure falls the mercury recedes and admits gas from the rubber tube joined to the U outside the column; the increase of gas-feed makes the flame under the flask shoot up, and the flask gets hotter. Then the vapour pressure rises in the column, and

the gas inlet is closed again. Thus the gas-feed may be adjusted within wide limits, from 30 drops down to 6 and fewer per minute. The gas which is not burnt has to be provided with an outlet, as the action of the regulator depends upon the gas pressure in the main, and this gas escapes through a bottle containing spindle oil; the escaping gas is burnt, a pilot flame being kept alight for this purpose. Thus there is a slight waste of gas; but the apparatus worked well.

The figures given by Mr. Bowrey were in good agreement. In a crude Trinidad oil he found thus: 0.52 per cent., 1.7 per cent. and 2.27 per cent. of benzene, toluene and xylene, the corresponding percentages for the spirit being 1.25, 4.11 and 5.48. Though the method is not perfect, it is preferable to others, and it was warmly welcomed.

DAMS AND WATER STORAGE.

THE utilisation of hydraulic power on the extensive scale warranted by the abundance and distribution of Canadian rivers has necessitated the conservation of water on a scale not contemplated in the most ambitious schemes of a very recent past. Canadian enterprise is seen in a very attractive aspect when taking effective measures to regulate and control the flow of the rivers, so as to derive from them the maximum amount of energy they are capable of rendering. For the problem of water conservation in Canada is not easily solved, since seasonal conditions materially affect the flow in the rivers. As a rule the winter precipitation takes the form of snow, the rivers are more or less frozen, and the run-off is considerably diminished, while abundant water is being collected to be discharged in the spring. Under a warm sun, with little shade or shelter, the ice breaks up quickly, and an enormous flood for a short period is the result. This excess becoming rapidly exhausted, a normal condition follows, to be rapidly reduced by evaporation in the autumn and further curtailed by frosts as the cycle begins again. The economic or mechanical value of a river depends upon the minimum flow in these alternating periods, and this forms but a small part of the total amount the river is capable of producing under efficient storage conditions. The importance of this fact cannot be insisted upon too strongly, for there is too frequently a tendency to overestimate the amount of the winter discharge, leading to an undue appreciation of the value of a natural river course. If the two feet or three feet of ice under which a river may be flowing be bored, and the water rises to the surface, the impression is created and the statement is made "that the stream runs all the winter just about as much as before freeze-up," but experience has shown that such deceptive appearances would result if the flow were only one-eighth or one-tenth that of the summer months.* The greater the irregularity in the flow of a river, the more vital from the power standpoint becomes the necessity of control and regulation.

The water supply throughout the Dominion is great, enormously great, but it is not infinite. As a matter of fact, hydro-electric developments in some districts have approached, or exceeded, the unregulated capacity of the exploited rivers, and with the continually pressing demand for power for industrial expansion, a demand that will be made with increasing persistence after the war, it behoves those in authority, by judicious and far-reaching schemes, to secure the maximum available output that prudent conservation and storage can effect. It is upon the recognition of this duty that we consider the Water Board of Canada is to be congratulated. Large unsurveyed areas in the unsettled parts have increased the difficulties on the one hand, but the many scattered lakes forming natural reservoirs have been of assistance on the other. The geological formation of the country generally has assisted the Board. The high banks, due in many cases to ice action, between which the rivers run, lend themselves to dam construction by offering good sites with solid foundation; the materials suitable for building dams are plentiful and found on the spot where they are needed. Moreover, the Government is early in the field, has control over all navigable rivers, and there are no vested interests with which it has to compete.

But whatever assistance may be offered by natural resources or prudent foresight, it must not be forgotten that large tracts of land, required as catchment areas or occupied by constructed works and reservoirs, are rendered practically unproductive, and though land up to the present has been of little value in the parts where water storage is most necessary, yet with the growth of population and the increase of agriculture and other industries, the remote forested Crown lands will appreciate in value to an extent as yet little considered. It is not impossible but that at no very distant future the claims of irrigation will compete with those of mechanical power, and some conflict of interests may be anticipated. One interest wants the energy and not the water, and the other the water and not the energy, and this division, if it could be made, is so far fortunate that in some cases it is found possible to satisfy the claims of both power production and irrigation necessities. On the Bow River, the important development of which is still in progress, it has been proved that the withdrawal of water for power purposes above Calgary does not interfere with the consumption of the same water required for irrigation below that city. This happy result follows from the irrigation demand being confined to the summer months, coincident with high flood discharge, when the capacity of the openings in the structures is taxed to the utmost to pass safely the abundant flow. On the other hand, the winter months' consumption for power purposes utilises the water conserved in the summer, independent of the needs of irrigation. Future developments will prove interesting. Confining attention solely to power purposes, the beneficial effect of storage in increasing and equalising the output is clearly demonstrated on the Bow River, where investigation has been thorough and much work has already been accomplished. The mean flow for the low-water months under natural conditions at Horseshoe Falls is recorded as 745 cub. ft. per second, but storage has doubled this quantity. At Calgary, below the mouth of the Elbow River, where the storage in that stream becomes effective, a flow approaching 2,000 cub. ft. per second is confidently anticipated, and has probably been attained. Every cubic foot will be needed, for in 1905 the municipality of Calgary, starting with a modest capacity of 260 kw., had in 1913 increased the consumption to 12,000 kw., and it is confidently expected that in 10 years an output of from 40,000 kw. to 45,000 kw. will be required.

In any complete system of water storage the dam must play an important part, both from the engineering and the financial point of view. In the calculated estimate the dam absorbs usually some 40 per cent. or 50 per cent. of the entire expense of the undertaking, and consequently many plans have been suggested for constructing dams that should reduce the cost without any sacrifice of stability. Where no roads exist and transport may be long and is always difficult, a concrete or masonry dam, from considerations of cost, becomes prohibitive. In the case of the Spray Lakes, a site that can be conveniently incorporated into the Bow River system, it is estimated that a barrel of cement landed at the works would, by the cheapest method of transportation, cost 6 dols. a barrel. Another type of structure becomes a necessity, and the constant repetition of such imposts as those just quoted has led to the evolution and perfection of the hydraulic-fill type. It is an inevitable extension of the rock-fill method, one that had its origin and development in California, and has much to recommend it where satisfactory rock can be quarried at a convenient elevation, so that the material can be handled by gravity at an economical figure. This form, however, has the disadvantage of involving the use of large quantities of concrete in order to obtain a watertight up-stream face, and requires much plant to handle the rock effectually. The hydraulic-fill type avoids some of these drawbacks, and under favourable conditions has been applied very satisfactorily to many structures. It offers the special advantage that the material is found on the spot where it is needed, and by skill and care permits a stable dam to be constructed from materials that would otherwise be useless and entail cost in removing. The general scheme of construction is effected by sluicing from the adjacent banks the material of a suitably-graded nature into the final position it is intended to occupy. By proper direction of the sluicing flumes the coarse friction-bearing stable material can be placed on the exterior slopes, and the finer particles assembled in the centre of the mass to serve as a puddle core. The ease and simplicity with which the operations can be carried out are recommendations as strong as is the economy effected. Again the suggestion came from California. It was the hydraulic giant or "monitor" that demonstrated the possibility of utilising streams of water, directed at a high velocity against the material in its natural bed, as a means for excavating, transporting and depositing the displaced material in its required position.

The ultimate stability of the structure depends greatly on selecting suitable materials. Rounded gravel, sand and boulders, intermixed with about 25 per cent. to 35 per cent. of clay, is found to bind satisfactorily. The rounded rocks roll more readily than broken angular chips, and the clay acts as a lubricant to assist in transporting the heavier materials. When clay is in excess its treatment becomes difficult, because it is unstable until the water is drained from the mass, and the drainage is slow. Shrinkage is greater than with other materials, and cracks may appear months after the work is finished, through which leakage can start if the dam be put in service too soon after completion. If, however, the difficulties are successfully overcome, and the clay is solidly compacted, it makes a dam which has no superior for watertightness. Mr. Conway, from whose report we are quoting, states that the glacial clays of British Columbia have proved themselves in every way satisfactory, and are superior to clays of a purer and richer character. Such clays, and also finely divided volcanic ash, though possessing none of the characteristics of clay, serve not only as a bond, but may be used for constructing an internal impervious core if such an addition be considered necessary.

Of the necessity of such a solid core, or one of solid masonry or concrete, opinion is divided, and it is easy to quote examples of successful structure in which this feature is both included and omitted. There is a similar want of uniformity in deciding the height to which this central core should be carried. Mr. Schuyler, who is responsible for many dams, urges that a core wall of masonry disturbs the homogeneity of structure by introducing a foreign inelastic element that tends to prevent the complete knitting of the mass as a whole in the manner that the particular construction was intended to promote. "The core wall must necessarily be built comparatively thin to be reasonable in cost, and must be subject to the minor defects of construction incident to all such work, and subject also to rupture from the possible uneven settlement of the earth on either side of it." But Mr. Schuyler admits, and apparently has the support of Mr. Hendry, that a core wall of moderate height in an earth dam founded on bedrock may be useful in forming a bond between the earth embankment and the bedrock on which it rests, but to serve such a purpose it should not be carried higher above the rock surface than is reasonable to ensure such a bond. In addition to these objections or cautions, it may be added that a core wall might prove a source of danger if it should impair the effective drainage of the structure. Mr. Conway urges such a wall might prove useful in preventing burrowing rodents making inroads but prefers to rely on properly repapped slopes as a sufficient defence against this somewhat remote danger.

We are concerned here only to point out that Canada is abundantly provided with the necessary means for constructing dams of this type, with any modifications that experience may show to be necessary. Her development of water power will not be delayed either by want of material or of ingenuity to turn it to account. Instances such as the Coquitlam Dam in British Columbia, constructed as part of the scheme for supplying electric energy

* "Bow River Power and Storage Investigations." By M. C. Hendry, prepared under the direction of the Superintendent of Water Powers.

to Vancouver city and neighbourhood, illustrated the capacity of the hydraulic process, even under such severe circumstances as the Canadian winter. Rapidity of construction will compensate for even such a heavy handicap. When the work of excavation was in progress as much as 11,000 cub. yards of material were removed in 120 hours of actual working time. This work was done with one "monitor," delivering 10 cub. ft. of water per second under a pressure of 110 lb. per square inch at the nozzle, the flume having a grade of 3 per cent. The average quantity of material sluiced into the dam was 47,000 cub. yards per month, and the greatest quantity 77,000 cub. yards. The total quantity of material in the dam amounted to 544,710 cub. yards, and of this total 489,130 yards were deposited by hydraulic process.

It is not necessary to refer here to the concrete dam of the hollow-buttress type, which has prevailed where heavy work of dam construction has been necessary. Some local feature may compel the adoption of an unusual form, such as that of the Prince Albert Dam, on the North Saskatchewan River. This dam is built on a clay stratum with sand underlay, and owing to a possible discharge at flood periods of as much as 180,000 cub. ft. of water per second, a spill apron of unusual length is required. The whole crest is used as a spillway, and in addition the spill capacity is augmented by sluices discharging through the dam. Such undertakings prove that the art of dam construction is by no means exhausted, and in a few years, when the northern rivers are brought under control, we may expect to see structures that rival in size the Roosevelt Dam of Arizona, or the lofty arched dam at Arrowrock, that controls the storage of the water in the Boise River.

THE NATIONAL PHYSICAL LABORATORY IN 1916–17.

THE General Board of the National Physical Laboratory met at Teddington on Tuesday last, the 19th inst., under the presidency of Sir J. J. Thomson, O.M. (who is *ex-officio* chairman of the board as president of the Royal Society), to receive the report of the executive committee for the year April 1, 1916, to March 31, 1917. War work had been the predominant feature of the activities of the staff, as in the two previous war years, and the Laboratory was not thrown open to visitors.

The report had to record the loss of three of its members, Sir Frederick Donaldson and Mr. Leslie Robertson, who perished together with Lord Kitchener, and Mr. David Howard, who had represented the Society of Chemical Industry on the executive from 1905 to 1914. The list of staff members on active service has risen to 49, and the names of 13 former members of the staff have to be added to this list. Two had been killed in 1915; that number, fortunately, remains unincreased, but it is to be feared that Mr. H. J. Head, who was reported as missing in October last, will never return. The staff has been further depleted or weakened by the claims made by various departments upon their time, especially upon that of senior members. On the other hand, new appointments have been made, and the present staff of 420, including 99 women, considerably exceeds that of 1916 (337) and previous years.

The director, Sir R. T. Glazebrook, F.R.S., C.B.—whose recent knighthood is claimed as an honour both by the Laboratory and by Trinity College, Cambridge, of which he is a Fellow—has continued to act as Adviser in Physics to the Ministry of Munitions, and is also an associate member of the Ordnance Committee; assisted by Dr. Rosenhain and Mr. T. Smith, he represents the Laboratory on the Standing Committee on Glass and Optical Instruments of the Department of Scientific and Industrial Research, as well as on the Advisory Councils for Technical Optics of the London County Council and the Imperial College of Science. Sir Richard has further become a member of the Main Committee of the Engineering Standards Committee, being particularly engaged in questions relating to electrical machinery and screw gauges. Dr. Stanton is on the Technical Committee of the Motor Industries (formed by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders), and on a committee investigating acetylene cylinders; both he and Dr. Rosenhain are members of the sub-committees of the Advisory Aeronautics Committee for Engines and Light Alloys. Dr. Harker and Mr. A. H. Rayner are lent to the Munitions Inventions Department; the former has also served on a committee reporting on fire extinguishers.* Mr. C. C. Paterson and Mr. J. W. T. Walsh have developed, for the Munitions Inventions Department, an apparatus of their own for use in connection with anti-aircraft gunnery; Mr. Jakeman has been greatly engaged in a similar manner, while Mr. F. E. Smith and Mr. H. C. Napier have devoted their energies to wireless problems. Dr. Rosenhain is serving on the Corrosion Committee of the Institute of Metals. Urgent Government work has, in fact, in all departments, necessitated the suspension of other research, and there has been little private testing carried on at the Laboratory; yet the total testing work has greatly increased.

The outstanding feature of the work has been the growth of the gauge testing. In August, 1915, the director was asked to arrange for the testing of some 30,000 gauges, to relieve the Inspection Department at Woolwich. In spite of great difficulties, 277,350 gauges were actually tested in the past year, the tests during November being carried out at the rate of between 4,000 and 5,000 tests per week. Meanwhile it had been arranged that all gauges required for the inspection of munitions, except those used only at the Arsenal and some few other special kinds of gauges, should pass through the Laboratory at the rate of 10,000 tests per week. This requirement necessitated important additions to both buildings and staff, and as the weather caused serious delays, rooms had to be utilised in the Optics Department and elsewhere, overtime became the rule, and the Laboratory was put on the "Warning List," to put out all lights on receipt of notice. Thus the gauge-testing capacity was brought up to 9,000 or 10,000 tests weekly, and the "Laboratory saved the situation," to quote the words of a high official. The report pays a warm tribute to the devotion and skill of Mr. J. E. Sears and the staff of the metrology department of the Laboratory.

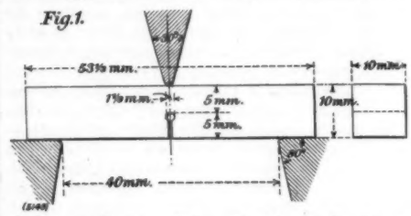
The question of a more adequate recognition of the services of the staff has been considered by a sub-committee of the executive in discussion with representatives of the staff. The question is closely connected with that of the relation of the Laboratory to the Department of Scientific and Industrial Research, and with the future position of the Laboratory. The executive feel strongly the necessity of improvements in several directions if the Laboratory is to make its full contribution to the national welfare. The importance of that work was urged upon the Government last November by a deputation from the Board of Scientific Societies, but the deliberations have been delayed by the reconstruction of the Government. The income for the year rose by 19,525*l.* (approximate) to 70,897*l.*, the fees for ordinary testing rising from 19,142*l.* to 23,657*l.*, the Treasury grant for aeronautics from 9,135*l.* to 14,169*l.*, and work done for the Ministry of Munitions from 10,908*l.* to 18,544*l.* On the other hand the expenditure increased from 49,804*l.* to 67,095*l.*, the salaries amounting to 50,409*l.*, instead of 37,350*l.* in 1915. The credit balance on the year's working was 3,806*l.*, 2,469*l.* of this being due to the Tank Department. The liquidation of the liability (of 1,661*l.*) of balance of loan for the completion of the National Tank has left a credit balance of 2,255*l.* in the general fund, to which 3,802*l.* excess of income over expenditure has to be added, bringing the balance to the credit of the fund up to 6,056*l.* 16*s.* 6*d.*

Donations have been received from the Institution of Mechanical Engineers for alloys research (200*l.*) and for hardness research (100*l.*); from Mr. John Dewrance, for optical glass research (100*l.*); from the Osram Lamp Company (200*l.*); and Lady Donaldson has presented part of the library of the late Sir Frederick Donaldson to the library. Grants for special researches have also been made by the Department of Scientific Research for optical glass (1,500*l.*) and for transmission of heat from surfaces to fluids (250*l.*); through the Institution of Electrical Engineers for research on the heating of buried cables (850*l.*); through the Engineering Standards Committee for notched bar impact testing (300*l.*).

Most of the last year's work of the Laboratory having been confidential, our account can only give an inadequate idea of the scope of the researches. Our report of last year appeared in our issues of June 23 and 30, and July 7, 1916. We begin with the Engineering Department, of which Dr. T. E. Stanton, F.R.S., M.Inst.C.E., is superintendent.

Engineering Department.—Notched-Bar Impact Testing. Hardness Tests. (Dr. Stanton, Mr. R. G. C. Batson.)—The testing of geometrically similar specimens, of different sizes, with the aid of the three pendulum hammers described on previous occasions, had to be discontinued on account of the urgency of standardising a small specimen for use in current practice. The International Congress for Testing Materials of Copenhagen, 1909, had adopted, not without opposition, the Charpy form of specimen (Fig. 1); the present research concerns the Charpy notch and the drilled hole at the bottom

Fig. 1.



of the notch-cut. Holes of this small size are difficult to machine in hard materials and absorb only a small amount of work (about 1 kg.-m.) in the fracture, too little for accurate measurements on machines of 25 kg.-m. capacity. Several testing laboratories hence make use of a rounded V-notch, thus doubling the amount of work absorbed. The Panel of the Engineering Standards Committee decided in July, 1916, on experiments to determine the best form of notch, having regard to (1) the form giving the most definite indication of brittleness, (2) the relative consistency of results from specimens of the same material and size, (3) the relative cost of production. The required specimens have been prepared at the Laboratory of a mild steel of 0.19 per cent. C and of a hard 0.654 C steel, and the first report to the Panel, dated December 13, 1916, dealt with (1) the International Charpy notch; (2) the 90 deg. sharp V-notch; (3) the 90 deg. rounded V-notch. As regards the mild steel, it resulted that a satisfactory degree of uniformity could be relied upon from all three types of notch, and that the sharpness of the notch did not appreciably affect the work done in fracture. In the case of the hard steel the results were much less uniform, partly owing, no doubt, to the small amount of work involved, and the sharpness of the notch had a marked effect on the resistance. In the next series of tests the sharpness was systematically varied, the notch, always of 90 deg., being made (1) as sharp as possible, (2) rounded to a radius of $\frac{1}{8}$ mm., (3) of $\frac{1}{4}$ mm., (4) of $\frac{3}{8}$ mm., and throughout the range of the experiments the energy absorbed in fracture was proportional to the radius of the notch. The further tests concern the irregularities observed and their possible mitigation by more elaborate heat treatment of the specimens or more refined methods of testing; the results will be compared with those obtained with the other testing machines of the Laboratory.

The hardness test research was brought before the Institution of Mechanical Engineers in their meeting of November 17, 1917, and we published the report by Dr. Stanton and Mr. Batson, as well as its discussion, in our issue of December 8, on pages 549 and 556. The broad results are that no definite relation was found between Brinell hardness and resistance to sliding abrasion, the fluctuations being particularly marked in the case of special alloy steels. Thus in a miscellaneous collection of steels the Brinell hardness is not a safe guide to their relative resistance to wear. The research has since

* See ENGINEERING, May 26, 1916, page 504.

been continued with special regard to the effect on the wear of variations in the velocity of sliding and the pressure on the surface.

Fatigue Resistance under Combined Stress.—The report by Dr. Stanton and Mr. Batson on fatigue under combined stress was presented to the British Association at Newcastle as an appendix to the report of the Committee on Stress Distribution in Engineering Materials.* The ratio of the twisting moment to the bending moment varied from 1.16 to 2.5, and the maximum shear stress from ± 11,800 lb. to ± 12,600 lb. per square inch. Since then further tests have been made at lower ratios of twisting to bending moment, and limiting maximum shear stresses of 14,800 lb. per square inch have been reached. Thus the experiments do not appear to support Guest's hypothesis that failure should be due to some particular value of the maximum shear stress; but as some speed characteristic of the machine might cause deviation from the law, slow-speed tests are now in hand. Wöhler tests are also made on fatigue at temperatures up to 200 deg. C. in oil baths; the fatigue is much hastened by the heat, even in steel.

Surface Roughness and Heat Transmission. (Dr. Stanton, Miss D. Marshall.)—According to Reynolds the heat transmitted from a hot surface to a fluid moving over it is proportional to the frictional resistance between fluid and surface. This was known to hold for commercially smooth surfaces, but in view of the attention now paid to raising the efficiency of air-cooled radiators, it is now being investigated whether artificial roughening will increase the heat transmission. The theory of Reynolds may not be valid, since it is based on convection of heat due to turbulent motion and may not be applicable to the large eddies thrown off from the edges of thin plates normal to the currents. The experiments are made with two brass pipes, 5 ft. high, 1⅛ in. diameter, the one in the smooth-drawn conditions, the other internally roughened by a screw-cutting tool. Water is circulated through the pipes at rates varying from 15 cm. to 100 cm. per second, the pipes being heated on the outside, by insulated Eureka coils, to certain temperatures above the water temperature, measured by means of thermo-couples and thermometers. The research is not yet completed, but shows the applicability of the theory for practical purposes; a less severe roughening than that obtained by cutting the screw would probably be efficient.

Cracks in the Tower Buildings.—Fortnightly observations on the growth of cracks in the buildings of the Tower of London have been conducted since September, 1915, and so far no serious disturbances have been detected. A careful examination of the roadway on the ancient quay wall facing the river has revealed movements of the wall; probably the whole block of masonry has been sliding towards the river, by not more than a few hundredths of an inch, fortunately. This total movement is yet considerably greater than that shown by any of the cracks, which it need not affect; Dr. Stanton is going to measure the amount of sliding.

Compressed Gas Cylinders.—The failures of some compressed gas cylinders are investigated by means of a special fatigue test, the pressure inside the cylinder, about 9 in. diameter, 5 ft. high, being caused to alternate between fixed limits, from 200 lb. to 400 lb. per square inch. A reciprocating plunger is fitted to a receiver connected to the delivery pipe of a hydraulic pump, the stroke of the plunger being set to the desired limits. The cylinders in question are welded, and failure ultimately takes place by the development of cracks in joints which would withstand the single application of a load many times the above value. The inference is that such cylinders should be drawn and not welded.

Timber Railway Sleepers. (Mr. C. Jakeman.)—On behalf of the Great Northern Railway Company the relative values of nine different timbers for railway sleepers have been determined. The timbers were supplied in pieces 9 ft. by 10 in. by 5 in., or 10 ft. by 12 in. by 6 in., from which specimens were cut for various tests: tension tests, shear tests, compression tests, in two directions and on two sizes of blocks; bending tests on a small beam, wet, normal or dry, and on a large beam; drop-weight tests; holding power of steel spikes and of an oak trenail; and bending tests of struts for three values of the ratio length to side of section. The absorption of water (soaking for up to 10 days), loss of weight on drying (in an air blast at 120 deg. F.), and change of dimensions wet and dry, as well as the density and number of rings, were also observed, and creosoting tests are going on. Drying increased the strength and decreased the deflection before fracture; the normal beam contained only little moisture, but behaved more nearly as the wet beam than as the dry one. Thus a small amount of moisture would appear to reduce the strength nearly to the lower limit, whilst the higher limit is only reached when the wood is very thoroughly dried. In the impact tests a weight of 57 lb. was dropped (through 6 in.) upon a steel punch, 1½ in. in diameter, resting on the surface of the wood, the indentation produced being measured after each of five blows; five more blows were then applied to the opposite face. The oak timber stood this test best, the indentation being less than 0.001 in. per blow; the longleaf pine, Russian larch, and the Portuguese red fir also passed well; Baltic redwood and Oregon pine, on the other hand, gave as much as 0.03 in. per blow, and should therefore have a larger bearing surface under the chairs than more resistant timber. Totalling the relative values of the seven mechanical tests, Mr. Jakeman finds the average quality value 0.777 for Baltic redwood, and the best values of 1.191 and 1.016 for oak and longleaf pine (the timbers are not further specified), for Oregon pine 0.691, whilst Russian redwood, 0.588, and Scot's pine, 0.507, came out worst. The mean density figures are in nearly the same sequence, and the ratio, timber value/density, is thus nearly constant. The results of the physical tests are curious. On soaking the longleaf pine increased 20.5 per cent. in density, the Russian redwood 115 per cent.; the volume changes in the wet and dry timbers varied from 10 per cent. to 15 per cent.; the changes in longitudinal dimensions did not exceed ½ per cent. mostly, but the changes across the fibre amounted to 5½ per cent. and 7 per cent. The changes in weight of the soaked woods varied very much; pitch pine resisted the entrance of water; the longleaf pine changed by 30 per cent., the Russian redwood by 127 per cent. Mr. Jakeman tested 504 specimens, but does not consider this number sufficient for assessing true mean values, though the results were in fair agreement. In general, American timbers seemed to be superior to European timbers, owing apparently to their higher density.

Aeronautics.—Important changes in the staff have taken place during the year, and quite recently Mr. L. Bairstow, chief of this division, has joined the Air Board; his name appears on the list of selected candidates for the Royal Society, and the executive congratulate him upon this recognition of his remarkable and successful work. Dr. Stanton takes charge of the division (Messrs. E. T. Relf, A. Fage, J. L. Naylor, J. R. Pannell, E. W. Stedman, L. W. Bryant, T. Lavender, H. B. Irving, W. L. Lowley, L. F. G. Simmons, R. Jones, R. A. Frazer, E. A. Griffiths, A Landells, H. Levy, and the volunteers, Norman Campbell, H. E. Collins, G. Pell, F. G. Woodford). In the two new wind channels, 4 ft. and 7 ft. diameters, air speeds of 80 ft. per second can be obtained, and the currents are steady, provided the local electric supply be steady. There was serious trouble when power presses in a factory of the district were joined to this source, and the voltage fluctuated badly in the Laboratory; a Tirril regulator of the British Thomson-Houston Company has helped over the difficulty. In equipping the channels and calibrating the new balances the anemometer of the Laboratory, which is itself calibrated on the whirling table within 0.1 per cent. of velocity, was used as standard; a standard wing section was then set up and tested in the new channel, and the results agreed with those obtained in the older channels. As the same accuracy of agreement has been realised in a comparison made by the Massachusetts Institute of Technology, and the Royal Aircraft Factory, which followed the Laboratory methods, the absolute accuracy of the methods is of a high order. New problems, calling for new methods with more complex models, have had to be solved, however. The airships studied are of the rigid and non-rigid types; the screens for shielding airships when entering sheds have demanded special attention; a report on the motion of the air in the neighbourhood of an airship shed and screen will soon be drawn up. A novel problem in the work on aeroplane wing models and aerofoils has been the investigation of the aerodynamic properties of triplanes; the deformations of the wing form, due to the sagging of the fabric, have also been reproduced on models. The experiments on kite balloons and their equilibrium have led to modifications of these balloons. The tests of complete models of aeroplanes and seaplanes in the 7-ft. channel show that the increased scale and speeds available in the larger channels do not lead to appreciable differences, whilst the larger sections and larger models, of course, offer considerable advantages. Stability and performance tests made at the Laboratory and the Royal Aircraft Factory allow of calculating the motion of an aeroplane when manœuvring and when looping and the stress problems involved. The shape of the aeroplane body depends much on the dimensions of the engine; the increase of resistance of the body due to the slip-stream from the propeller has been experimentally investigated both for pusher and tractor types of aeroplanes. Propellers are tested in the channel, on ⅛-scale models, *e.g.*, and also on the whirling table. The study of the air flow round a propeller justifies many factors of the empirical designs in use, whilst showing reasons for large errors in applying the older methods of calculation to the problem of direct lift. Full-scale tests of the performance of aeroplanes have also been conducted, and the trajectories of aerial bombs are among the special problems investigated.

(*To be continued.*)

* See ENGINEERING, vol. cii, page 268, September 15, 1916.

NOTES.

GLUCINUM (BERYLLIUM) AND ITS ALLOYS.

BERYLLIUM, Be (discovered and so named by Wöhler, 1828), or glucinum, Gl, shares with niobium, Nb (isolated by Rose, 1844), or columbium, Cb, the unenviable distinction not only of being known under two names, but also of being designated by two symbols. To mark their disapproval of this treatment the two metals are still giving experimenters a great deal of trouble. Beryllium was supposed to resemble magnesium closely and to be an excellent conductor of electricity, until Fichter disproved the resemblance to magnesium in 1913, and showed that beryllium had a hardness of more than 6, and that its conductivity was only one-twelfth that of copper; the name glucinum, used in England, had been adopted because the salts have a sweetish taste, differing in that respect strongly from the bitter magnesium salts. Investigating the metal and its alloys, G. Oesterheld (*Zeitschrift für Anorganische Chemie*, 97, pages 1 to 41, September, 1916) started, like Fichter, from the double fluoride $NaBe_2F_5$ (prepared from the carbonate), which he fuses and electrolyses; the reduced metallic powder is compressed into cylinders which are melted in a vertical vacuum electric furnace at 1,300 deg. or 1,400 deg. C., when a metal of 99.5 per cent. fuses out; this glucinum melts at 1,278 ± 5 deg. C. The difficulties of the preparation are that the first obtained powder retains sodium fluoride, and that it is very prone to cover itself with a film of oxide and to form a carbide; in the presence of carbon monoxide both these compounds are formed. The heat of fusion of this metal, 277 cal. per gramme, is the highest known for metals, as was to be expected considering the high melting-point and the low atomic weight, 9; according to Compton's rule it should be higher still, 341 cal. Oesterheld prepares his alloys in tubes or crucibles of unglazed porcelain or of magnesia. Glucinum and aluminium, he finds, are miscible in the liquid state; they do not form any compounds, and the solid solutions contain 8 per cent. of Al maximum; the eutectic point is 644 deg. C. The alloys with copper are of a complex character. Two compounds, Cu_2Gl and $CuGl_2$, seem

to be formed, in addition to four series of mixed crystals. The addition of glucinum to iron lowers the magnetic transformation-point of iron to 650 deg. C; there is one compound, probably $FeGl_2$, which melts between 1,400 deg. and 1,450 deg. C. Silver and glucinum do not combine and give only a limited range of solid solutions; with increasing glucinum percentage the ductility increases, whilst the hardness decreases. The study of alloys of magnesium and glucinum would have been particularly interesting; but magnesium boils at ordinary pressure below the melting-point of glucinum, and it is not known, therefore, whether the two metals are miscible or not. Oesterheld, who works under Fichter at Göttingen, had only small bulks of metal to deal with, and in view of the high experimental difficulties further investigations will be necessary.

The Crystal Structure of Iron.

In submitting iron to an analysis by X-rays, Mr. A. W. Hull, of the Research Laboratory of the General Electric Company at Schenectady, first made use of a steel which contained 3.5 per cent. of silicon, but practically no carbon, because this steel was hard, and the crystals formed by long annealing could be split along cleavage planes, without distortion, into plates about 6 mm. square, 2 mm. thick. The X-rays from a Coolidge tube with a tungsten target were passed through the crystals in a direction nearly parallel to one of the principal planes. The study of the K-line spectrum suggested that the crystal lattice would have atoms at each corner and at the centre of a cube, the spacing of the planes, *i.e.*, the length of the side of the cube, being 1.43×10^{-8} cm. In the second series of experiments pure iron was reduced, in the form of a powder, from the oxide by means of hydrogen, and the X-rays were passed through the particles, so as to produce a kind of generalised Laue photograph. In these photographs dark spots, or concentric K-lines, surround the central dark spot (marking the direct ray), each possible plane in the crystal structure having an equal opportunity of reflecting the rays, which were not (as in the former Bragg arrangement) uniform, but of all wave-lengths; the Coolidge tube was run at 110,000 volts. The distances between the concentric lines should be approximately inversely proportional to the spacing of the planes. When these lines and their distances are calculated, every line calculated should be present, but no other lines should be observed, and the intensity of the lines should decrease in a definite ratio if the assumed structure of the crystal be correct. It resulted that, supposing the atoms to be arranged on a centred space lattice (as mentioned above), and the electrons of each atom concentrated at its centre, the observations failed to account for three facts: the decrease in the intensity of the lines was not continuous with increasing distance from the centre; the first order reflection from the principal plane 100 was much too weak; and the second order reflection from this plane was altogether missing. Unable to account for these peculiarities by any other probable structure, Mr. Hull, in bringing these researches before the Cleveland meeting of the American Physical Society last October, suggested an influence of the internal structure of the atom. Crediting the atom of iron with 26 (atomic number of the iron atom) electrons, he tried various ways of grouping the electrons in the atoms, finally finding that the peculiarities would be explained if all the electrons were not concentrated at the centre, but displaced from the centre of the cube along the cube diagonals in four groups of 2, 8, 8, 8 electrons at $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$ of the distance of the nearest atom respectively. He presumes that the rays, by the time of their arrival at the crystal, consist of long trains of waves to which the electromagnetic theory is applicable; that the scattering of the rays is entirely due to the electrons, which all scatter independently and equally; that the number of electrons in an atom is equal to its atomic number; and that the electrons have fixed positions in the atom, about which they move in very small orbits. The whole arguments are bold, but they indicate a way, of regarding the phenomena, and the proposed grouping of the electrons would concord with the valency of iron and with the phenomena of ferro-magnetism. Similar arguments, we should add, have been used by Mr. A. H. Compton, of Princeton University (*Physical Review*, January, 1917), in a general consideration of the distribution of the electrons in the atoms.

INDUSTRIAL NOTES.

The Director of the Department of Labour Statistics, writing in *The Board of Trade Labour Gazette* on the state of the labour market in May, says that nearly all the principal industries were fully employed, and in many cases the depleted staffs were working at great pressure with much overtime.

The increases in wages and war bonuses reported to the Department as taking effect in May affected over 290,000 workpeople, and resulted in a total increase of nearly 45,500*l.* per week. No decreases were reported. These figures include numerous increases in the building trade, the national scheme of war bonuses introduced in the boot and shoe industry, and the increased bonuses granted to pottery workers in North Staffordshire. A large number of transport workers, including dock labourers and omnibus and tramway men in London, are also included in the above figures.

Exclusive of the principal dispute in the engineering trades, as to which full particulars are not yet available, the number of disputes beginning in May was 42, affecting 29,977 workpeople. The latter figure, when added to the number of workpeople involved in disputes which began before May and were still in progress at the beginning of the month, gives a total of 37,239 workpeople, as compared with 25,534 in the previous month and 30,439 in May, 1916.

The average weekly number of vacancies notified to all Employment Exchanges for the four weeks ended May 11, 1917, was 39,536, as compared with 39,967 in the previous five weeks and with 37,717 in the four weeks ended May 12, 1916.

The average weekly numbers of vacancies filled for the same periods were 32,182, 32,096 and 28,661, respectively.

Retail prices of food in the United Kingdom on June 2 were about 2 per cent. higher than a month earlier. As compared with a year ago they showed an increase of about 28 per cent. The increase from July, 1914, in the cost of all items ordinarily entering into working-class family expenditure, including food, rent, clothing, fuel and light, &c., may be estimated at between 70 per cent. and 75 per cent., taking the same quantities and descriptions of the various items and eliminating advances arising from increased taxation. In regard to the movement of retail food prices in Berlin and Vienna, no particulars of recent date can be given, as official figures have not been received. During February retail food prices as a whole in Italy increased by 7.1 per cent., as compared with those of the preceding month, and were 54.4 per cent. higher than in July, 1914. The index number representing the general level of retail food prices in the United States showed no change on March 15 last, as compared with February 15, and on the former date was, again, 30 per cent. higher than in July, 1914.

Previous wars, says *Power*, New York, were fought largely by the labouring classes. To them not only fell the work of doing the actual fighting, but they were also heavily taxed to pay the expense of actually carrying on the struggle, the capitalists and captains of industry to a large extent considering their country's difficulties an opportunity to advance their own selfish interests.

What may be said of the man of influence and position of the past cannot be said in this crisis; to-day we find him taking the position of first rank in the Government service. Engineers of every class, who are capable of commanding high salaries in the employ of private corporations, are proffering their service gratis and working for the Government without compensation. The leading men of public utility corporations and industries of almost every kind have come forward and offered their services to the Government to assist in meeting the problems of this great crisis. Consequently, to-day, the Government has at its command the greatest force of engineering and industrial talent that any country has ever been able to boast of in the history of the world. Not alone have these leaders responded, but the industries themselves have shown that they are willing to do their part. Thus, the steel and copper corporations have offered to supply the Government with these materials at extremely low prices. The tentative tax rates indicate that the financial burden is also going to fall upon, and justly so, those with the large incomes. Not only corporations' profits, but also private incomes are to be heavily taxed, and excess profits in part requisitioned.

One of the great problems is that of labour; the United States is lacking 6,000,000 men, and there is the prospect of conditions becoming more acute with vast numbers enlisting in the Army and Navy and with the increased demand upon the industries to supply the needs of the war machine. No doubt many of the places made vacant by the men who go to the front will be supplied by women, but there are many positions that can be filled only by skilled male labour. This, adds our American contemporary, is the opportunity for the responsible heads of labour organisations to assist in solving this great problem.

It is to be hoped, concludes our contemporary, that the American labour organisations will profit by the mistakes of the labour interests as witnessed in England the first year of the war, and not put selfish interests before the needs of the country and the needs of the men in the trenches, who were during the first year of the war practically defending themselves with their naked hands. "Since our declaration of war the soldiers in the trenches defending the battle fronts of our Allies are no longer English, French, &c., but our soldiers; if not in nationality, they are in purpose. Therefore it is our duty to see that they are equipped with everything that is necessary to make them as efficient as possible."

In order to promote the further development of the dye-making industry in the United Kingdom the President of the Board of Trade has decided to establish a special temporary Department of the Board of Trade to deal with matters relating to the encouragement, organisation and, so far as necessary, the regulation of that industry. The department will be under the direction of Sir Evan Jones, Bart., M.Inst.C.E., who has placed his services at the disposal of the President, and who will have the official title of Commissioner for Dyes. The Commissioner will act in close consultation with the various dye-making and dye-using interests concerned.

Any communications on the subject should be addressed to: Commissioner for Dyes, Board of Trade, 7, Whitehall Gardens, London, S.W. 1.

We are informed that the India Rubber, Gutta Percha and Telegraph Company, Silvertown, have received an official permit for putting down an establishment at Burton-on-Trent. The new works will occupy an area of about 50 acres, and will be connected to the railway by a siding.

The Ministry of Labour last week issued a note calling the attention of employers and workmen in insured trades to the fact that the unemployment books for 1916–17 cease to be current on July 14, 1917, and must be exchanged for new books during the week ending July 21, 1917.

For the purpose of this exchange the unemployment books for 1916–17 should be returned as early as possible in the week ending July 21, 1917, to the nearest Employment Exchange or other local office of the unemployment fund. Special facilities are offered by the department to employers whereby, if the necessary particulars of the old books are furnished in good time, the corresponding new books will be made out beforehand and will be ready for issue as soon as the old books are returned after July 14. Where such arrangements have not been made it will be necessary to make out the new books after the return of the old books, and the issue of the new books cannot take place until after the interval necessary for the purpose. Employers desiring to avail themselves of the facilities referred to should communicate immediately with the nearest Employment Exchange or other local office of the unemployment fund, if they have not already done so.

Employers are also reminded that applications for refunds under Section 94 of the National Insurance Act, 1911, as amended by Section 5 of the National Insurance (Part II Amendment) Act, 1914, for the insurance year ending on July 14, 1917, must be made in the prescribed manner, and not later than September 14, 1917. The necessary forms of application and memorandum of instructions (U.I. 220) will be obtainable shortly before July 14 at any Employment Exchange or other local office of the unemployment fund. The department cannot entertain any application which is not made in due time and in the prescribed manner; they cannot undertake any responsibility in the case of an employer desiring to make a claim who does not procure the forms of application in time to enable the forms to be duly completed and lodged at a local office of the unemployment fund on or before September 14, 1917. The provisions for refund do not apply to workmen insured under the National Insurance (Part II) (Munition Workers) Act of 1916.

The Controller of Coal Mines recently circulated a large number of forms asking for information regarding coal used by steam boiler owners throughout the country. Many of these have not yet been returned, and firms who have received such forms are therefore requested to forward the particulars asked for to the Controller at once. Otherwise it may not be possible for their requirements to receive consideration in

connection with a scheme which is being prepared to enable a suitable supply to be maintained for all concerned.

Any firms or persons using coal for land boilers who have not received a copy of the form should apply to the Controller of Coal Mines, Box D.S.R., 8, Richmond-terrace, Whitehall, S.W. 1.

We read in *The American Marine Engineer* that an agreement was signed last month by the American Seamen's Union and the employers, greatly increasing the wages to be paid the men.

By the terms of this agreement able-bodied seamen are to receive an advance of 15 dols. a month, making their wages 65 dols.; firemen get a rise of 10 dols., making their wages 60 dols. a month; oilers and boiler tenders get an advance of 10 dols., raising their wages to 65 dols.; both first and second pumpmen are advanced 10 dols. a month, making their wages 70 dols. and 65 dols. a month respectively, and boss carpenters are increased 15 dols. a month, making their wages 70 dols. It was also provided in the agreement that during the time the vessels were in the war zone there should be an increase in wages of 50 per cent.

Approximately 2,500 of the 15,000 experienced ship carpenters needed by the Shipping Board to build its great fleet of wooden vessels have been found by the Department of Labour in two days of its nation-wide inquiry, says *The American Marine Engineer*, in a note dated Washington, April 28. The work was then still progressing.

Preliminary reports from San Francisco indicated that 650 shipwrights, 150 caulkers, 300 joiners, 100 boat builders, and 100 machine hands had been found in that vicinity.

Philadelphia reported approximately 700. About 150 had been located in Cleveland, and more than 200 in Baltimore. In Kansas City and Galveston the department's agents reported success. Investigations were being carried on in Beaumont, Port Arthur, Orange, and other ports along the Gulf Coast.

In the Ohio and Mississippi River towns near St. Louis a considerable number of boat carpenters had been located by the department's agents from St. Louis and Memphis.

In the course of his address at the annual conference of the National Union of Railwaymen, held in the Memorial Hall, London, on Monday last, Mr. A. Bellamy, the president, expressed gratification at the increase in membership in four years from 132,000 to 340,131, and added that progress towards their ideal of one union for railwaymen was being made. They had learned with pleasure that the railway clerks' conference at Chester had instructed their executive to enter into negotiations for amalgamation. During the year various proposals had been made with regard to the further release of railwaymen for the Colours. The executive viewed the whole question as of prime national importance, and it was a grave question whether the number of those released had not, in the national interest, almost reached the limit. They would continue to keep in close touch with the authorities on this question. With regard to after-war problems, he said he hoped the decisions of the Manchester Conference of the Labour Party would receive the enthusiastic support of their members when reconstruction passed from theory to practice. What was to be the position of railwaymen after the war? The sacrifices they had made at least ought to be recognised to the extent of assuring them very much improved conditions in the future. There were strong reasons why the Government should never again lose control of the railways. Personally, he considered the best method would be for the Government to acquire and work the railways, but whether nationalisation or control were decided upon, it ought to be made unmistakably clear that neither system would be acceptable to railwaymen unless they were given a share in the management. Surely it was not too much to ask that representatives of railwaymen should have a place on the Board of Control.

GERMAN WAR PROFITS.

THE Zincke-Hofmann works, in Breslau, which builds locomotives and wagons, earned last year net profits of 3,917,701 marks, against 2,836,539 marks for the previous year. The preference shareholders obtain 4½ per cent. and the ordinary shareholders a dividend of 24 per cent., against 17 per cent. for the previous year. Sums applied to welfare institutions amount to 37 per cent. of the ordinary dividend.

The Company for Aniline Manufacture in Berlin has paid a dividend for last year of 17 per cent., as in the preceding year, but in addition the shareholders obtain a bonus for last year of 7 per cent.

The Frankfort Asbestos Company has paid a dividend for last year of 15 per cent., and in addition the shareholders obtain a bonus of 100 marks in war loan.

The Turbinia Company, Berlin, which is closely connected with the Brown-Boveri Company, has paid a dividend for last year of 20 per cent. Prospects for the current year are satisfactory.

The Galvanising and Iron Construction Company, in Rheinbrohl, has paid a dividend of 16 per cent. for last year, the same as for the preceding year, but the shareholders in addition obtain a bonus of 200 marks per share in war loan.

The German Arms and Ammunition Works has paid a dividend of 30 per cent. for last year, in addition to which large sums are understood to have been applied to what is called still or invisible reserves.

The Slomann Nitrate Works, in Hamburg, has paid a dividend for last year of 20 per cent., against 15 per cent. for the preceding year, the net profits for the two years being respectively 5,682,285 marks and 4,785,149 marks. The production had materially increased, amounting respectively to 3,700,000 Spanish cwt. and 1,178,000 Spanish cwt. The shipments to neutral countries amounted to 2,835,250 Spanish cwt., against 2,254,915 Spanish cwt. during the preceding year, when the stocks were pretty well cleared out, whilst they now amount to about 1,000,000 Spanish cwt. Prior to the net profits being arrived at, 1,000,000 marks had been added to a fund for restarting works temporarily stopped, which fund, bearing the characteristic German name of *Wiederinbetriebsetzungskonto*, now amounts to 3,037,739 marks.

The Rhenania Chemical Works, Aachen, has paid a dividend of 25 per cent. for last year, against 20 per cent. for the previous year, the gross profits amounting to 4,429,138 marks, against 1,882,188 marks for 1915; in addition, the shareholders on the register of the company at December 1 of the current year will, in January, 1918, obtain an extra bonus of 50 per cent.

The Daimler Motor Company, Stuttgart, has paid a dividend of 35 per cent. for last year, against 28 per cent. for the preceding year. The turnover was still increasing, but otherwise the Board refused any further information at the present time. The Daimler Motor Company had subscribed 18,000,000 marks to the last war loan.

VULGAR *v.* DECIMAL FRACTIONS.

TO THE EDITOR OF ENGINEERING.

SIR,—The statement with regard to the height of Mount Everest contained in Mr. Burton's letter on the subject of "Vulgar *versus* Decimal Fractions," in ENGINEERING of March 16, 1917, gives a wholly wrong idea as to how the figure 29,002 was derived.

It is curious that it should have been supposed that the height was first worked out in metres and afterwards converted into feet.

The height of Everest was determined in the years 1849-50 by observations from six different stations in the plains of Bengal. The results obtained were:—

1	...	...	...	...	...	28,991.6
2	...	...	...	...	...	29,005.3
3	...	...	...	...	...	29,001.8
4	...	...	...	...	...	28,998.6
5	...	...	...	...	...	29,026.1
6	...	...	...	...	...	28,990.4
	Mean	...	...	...		29,002.3

The final 2 has been retained because, owing to the accident of the value being so nearly a multiple of 1,000 ft., to have omitted it might have given rise to the idea that the height had only been roughly determined; it is not, of course, claimed that the 2 has any significance.

I may also perhaps remark that the equivalent of 8,850 m. is 29,036 ft. 29,002 ft. converted into metres gives 8,839.8. If Continental geographies give 8,850, I suppose that this number is used in preference to 8,840 to indicate that the result is only good to the nearest 25 m. or so; but I think this is rather a dangerous plan, for it might easily lead to 8,900 m. being adopted by someone with a still stronger preference for round numbers, and this converted back into feet gives 29,200, which is appreciably different from the original figure.

I think that Sir Andrew Waugh's decision to adopt 29,002 as the height of Mount Everest was a wise one.

Yours truly,

J. P. LENOX CONYNGHAM, Colonel.

Office of the Trigonometrical Survey, Dehra-Dun, India, May 7, 1917.

OIL ENGINE NOMENCLATURE.

TO THE EDITOR OF ENGINEERING.

SIR,—May I again ask the courtesy of a little space in your columns in order to make quite clear to your readers the distinction in my *two* patent crude oil engine cycles as expressed in the separate letters patent specification as follows:—

Patent 7146, May 8, 1890.

One cycle of the engine or motor may be as follows:—"The induction stroke, which is the *first outward* stroke, instead of drawing into the cylinder a mixture of hydrocarbon vapour and air, simply draws in *atmospheric air*, the compression or *first return* stroke *compressing this air* into the intensely heated vaporiser, and at the *desired part* of this *compression stroke* the *supply of liquid hydrocarbon* is forced in a *spray* form into the heated vaporiser which almost instantly changes into a gas, it combines with the heated air; *automatic ignition takes place* and propels the piston, which forms the working or *second* outward stroke. The return stroke of the piston clears the products of combustion from the cylinder, and so on."

And the description in the complete specification states:—"The operation of the engine is as follows: That is to say, assuming the parts to be in the position shown in Fig. 1 and a suitable lamp to have been placed beneath the vaporiser so as to heat it to the desired degree. If now the flywheel be turned in the direction of the arrow, the *outward stroke* of the *piston will draw* in a *charge of air* through the valve, which charge, on the return of the said piston, will be compressed. In the meantime the pump will have been drawing from the oil tank a charge of oil, and at or *about the time that the piston commences* to make its *second outward stroke* the oil will be *sprayed* into the vaporiser and with the *compressed air therein* form an explosive mixture which owing to the heat of the vaporiser is ignited thereby, driving the piston forward; on the return stroke of the piston the exhaust valve is opened and the exhaustion of the products of combustion from the cylinder takes place, and so on, as hereinbefore described."

Patent No. 15994, October 8, 1892.

The beginning of this patent specification reads:—"In the specification filed with Letters Patent, dated May 8, 1890, No. 7146, I have described means for preventing the pre-ignition of an explosive charge of combustible vapour or gas and air, when a permanent igniter (such as a *continuous electric spark* or a highly heated igniting chamber) is in communication with the interior of the cylinder, by *first of all compressing* the *necessary quantity of air* for the *charge* and then *introducing* into this quantity of *compressed air* the necessary supply of *combustible vapour* or gas to produce the explosive mixture. *The chief object* of the present invention is to provide a means whereby the necessary quantities of combustible vapour or gas and air may be drawn in during the *suction stroke* of the piston, notwithstanding that a *permanent igniter* is employed, without liability of *pre-ignition*. This is the patent under which the world-wide renowned "Hornsby-Akroyd" oil engines were made.

I made and sold at Bletchley Iron Works, Bletchley, Bucks, in 1890–91 "Akroyd" crude oil engines, *fitted* with *adjustable cam* to *time* the *oil fuel injection*, Patent No. 7146, May 8, 1890, to the following:—

One 2 brake horse-power: The London and North-Western Railway Company's Works, Crewe.

One 2 brake horse-power: The Woburn Sands Aerated Mineral Water Works Company, Limited, Woburn Sands, Beds.

One 1 brake horse-power: The North Bucks Press Company, Limited, Fenny Stratford, Bucks.

I also supplied three engines to Messrs. Hornsby and Sons, Grantham, for experimental purposes. Two of these engines were fitted with an adjustable cam to time the oil fuel injection.

If all the information I have submitted is insufficient to establish my claim as pioneer to the so-called semi-Diesel type of crude oil engine, I am prepared to go to London and build an engine in accordance with the specification and drawings of Letters Patent No. 7146, May 8, 1890, and adjust and run such engine before a committee of engineers under all loads to produce indicator diagrams similar to diagrams 1, 2, 3, on the sheet of drawings herewith.

I send you official printed specifications and drawings of my patents Nos. 7346, 15994, 3909, referred to in my several letters.

Yours faithfully,

HERBERT AKROYD STUART, M.I.M.E.

Akroydon, Claremont, Western Australia, April 23, 1917.

"THE ELECTRICAL PROPERTIES OF GASES."

TO THE EDITOR OF ENGINEERING.

SIR,—As neither "An Old Millwright" nor "Earnest Student" nor "Sesamy" has disclaimed my suggestion that all three are one and the same individual, your readers will draw the inevitable inference. The incident serves to show the hopelessness of argument with one who considers such a multiplication of "men in buckram" a fair method of controversy.

The prospect of an easily earned twenty guineas or so by accepting the offer of "An Old Millwright" is tempting, but on principle I make it a point to have as little as possible to do with cranks, whether of the perpetual-motion type or less pernicious brands.

I entered this controversy only to give a straightforward answer to certain definite questions which he now repeats under his "Earnest Student" *alias*. As he ignores this reply, but is trying to widen the issue in his character of "An Old Millwright," I repeat my answer here. The facts to which he refers have been demonstrated in the same way and in the same sense as has the reign (at least to a very close first approximation) of Newton's laws throughout the solar system.

Of course, if "Sesamy" *alias* "Earnest Student" *alias* "An Old Millwright" is prepared to maintain that it has not been *proved* that Newton's laws do apply to the solar system, I am quite prepared to agree with him, and will even go further and state that the very existence of the external world is in itself incapable of "proof."

Yours truly,

Croydon, June 8, 1917. DIDYMUS.

INDUSTRIAL RESEARCH IN THE UNITED STATES.—The Department of Scientific and Industrial Research has issued through H.M. Stationery Office a report by Mr. A. P. M. Fleming, giving descriptions of the laboratories in various works in the United States, and in educational, State and private institutions, with a statement of the endowment funds available, and a discussion of legislation and other influences tending towards the nationalisation of research, and of the methods of selecting and training scientific investigators and co-ordinating their activities and results. The aim has been to note those features and that trend of development in the United States which appear to bear on our own national problems. The price is 1s. net.

MARINE APPLICATION OF REDUCTION GEARS OF FLOATING FRAME TYPE.

To the Editor of Engineering.

Sir,—I thank you for the publication of my paper and the discussion on it in your issue of April 6.* I also thank those who have kindly discussed it, and they raise questions of interest which call for further data and remarks. I trust I am not discourteous to the Institution of Naval Architects in giving this reply in Engineering without awaiting their official report of the discussion. I am prompted by the desire to give the additional data and meet any criticisms as promptly as possible.

I have also read the discussion in *The Syren* and *The Shipping World* for April 4, which supplement, on a few points, that in Engineering; hence my reply may be somewhat fuller than it would otherwise have been.

Gears are, of course, designed for the highest load cent. The dates on which these units were put in service are as follow:—

(A) April 4, 1914; works at seven-eighths of overload rating about 16 hours per day, 7 days per week. This gives a power constant of 3.54.

(B) April 12, 1915: works at 1,000 kw. usually, with frequent overloads up to 1,250 kw., for 24 hours per day and 7 days per week. This gives a power constant fluctuating between 3.24 and 4.05.

(C) November 1, 1914; works 12 hours to 16 hours per day, 6 days per week, at a fluctuating load up to 1,250 kw. This gives a maximum power constant of 4.05.

Gears were supplied to (D) the Jacob Ruppert Brewing Company, and (E) the Schoenhofen Brewing Company. Pinion 3.9 in. pitch-circle diameter, 3,600 r.p.m., overload rating 550 kw. These run 24 hours per day in summer, for 6 days per week, at from 400 kw. to 500 kw. The power constant for 500 kw. is 3.41. (D) was put in service on June 5, 1914, and (E) on August 14, 1914.

gears are frequently designed for power constants about as high as those I gave, either the data have not been published or I have overlooked them. In the "Table of Gear Data"* in my article "On Reduction Gears" I gave the three highest examples of power constants for marine rigid gears which I knew. These were:—

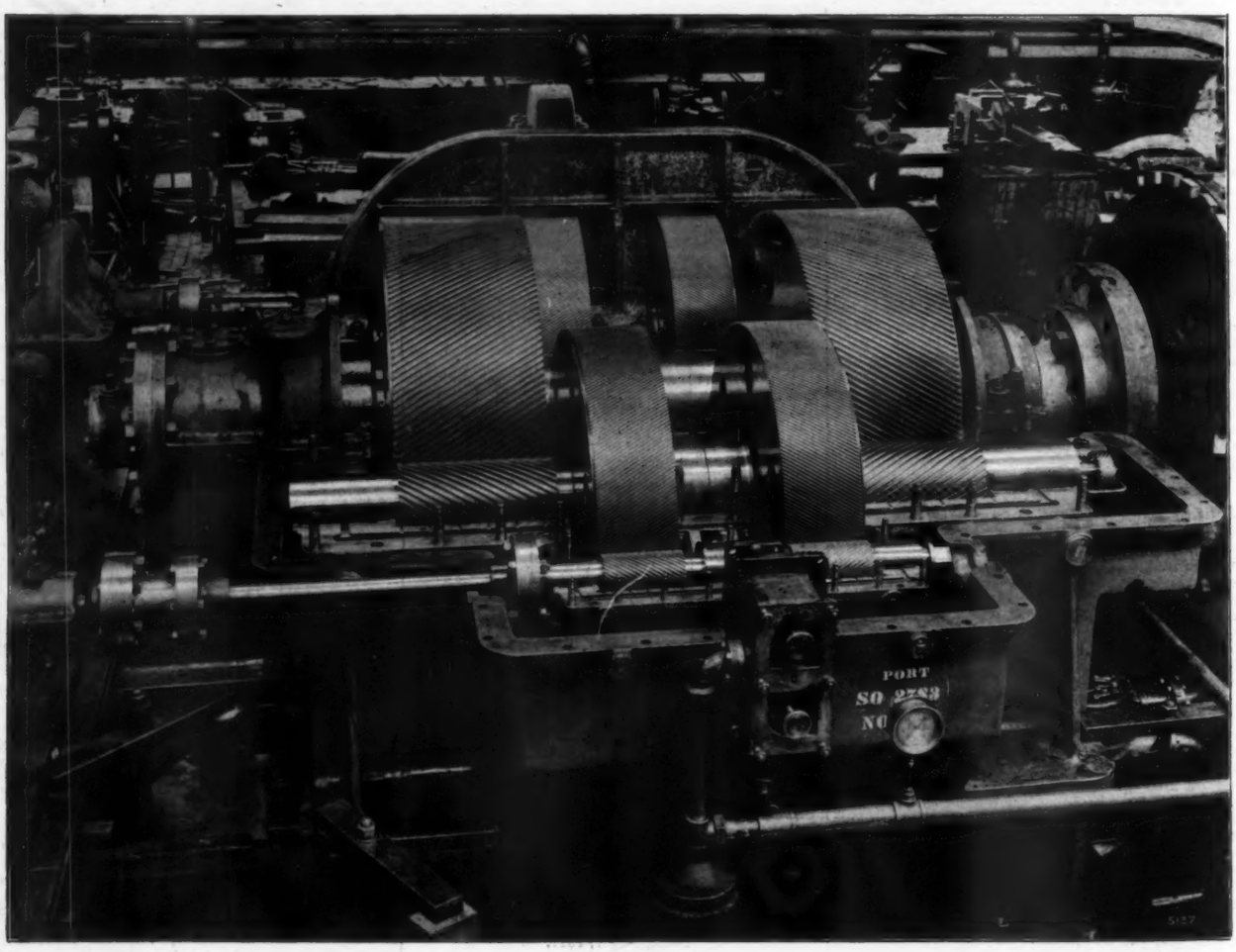
(*a*) The Vespasian, power constant = 3. This is the highest result of a progressive trial trip and was of a few minutes' duration. The published data shows that, for the average speed of the ship, the power constant is 1.85.

(*b*) Highest trial run of s.s. Tuscania gave 1.80; also of a few minutes' duration.

(*c*) Official measured mile trial results of s.s. Ciudad de Buenos Aires and Ciudad de Monte Video gave 2.58 for the high-pressure pinion and 1.29 for the low-pressure.

Values for land gears are usually lower than for marine gears.

The following recent proposals may be of interest, and they seem to indicate that power constant for rigid



they are guaranteed to transmit. In the case of electric generators it is usually specified that an overload has to be carried for a certain time—most frequently 25 per cent. overload for two hours or more. The power constant of the gears is settled on for this condition, and is such that this load could safely be borne continuously. In marine applications the power constant chosen is for the maximum guaranteed power and speed of the ship. Here there is no time limit.

Mr. Butler is correct in supposing that the earlier floating-frame gears had lower power constants. These were gradually raised as experience was gained. Thus of the two last examples given in my paper, the San Diego Electric Company's gear has only a power constant of 1.635, but the Cleveland Electric Illuminating Company's gears, the first of which was started on December 4, 1912, has a power constant of 2.72. As he requests, I give data of more recent years with higher power constants.

The gears supplied to the following three firms were from the same patterns: (A) Eastman Kodak Company; (B) Federal Rubber Company; (C) Aluminium Company of America. Pinion 5 in. pitch-circle diameter, 3,600 r.p.m.; overload rating 1,250 kw., normal rating 1,000 kw. Each drives a direct-current generator, for which, in what follows, I take the efficiency as 92 per

* Pages 321 and 333.

All these have given excellent service and are in perfect condition to-day. Indeed, the same can be said of every floating-frame gear which has been put in service, except the first gears of U.S.S. Neptune. These were replaced for no defect of the gears, but in replacing the turbines the revolutions per minute were much raised, requiring change of gear ratio.

U.S.S. Neptune has been in service since her official trials in November, 1915, at speeds from 12 knots to over 14 knots. I am informed that there have been considerable periods at speeds which would give a power constant from 4.3 to 5.3. Here most continuous service has been in the last year, and the log shows that between April 1, 1916, and March 31, 1917, she steamed about 40,000 miles. The speed for most of this distance was from 12 knots to 13 knots, which would give power constants from about 3.5 to 4.3. The gear teeth, examined a few days ago, are in excellent condition.

The present practice of the Westinghouse Machine Company is to make a power constant of 3.0 at normal load for gears driving electric generators, the value being kept a little low, as a short circuit greatly increases the stress for a short period; a value of 3.5 for merchant ships as these may run frequently and for long periods at full speed; and a value of 4.0 for naval vessels.

It probably would have been well had I given the foregoing data in my paper, as they would have answered some of Mr. Butler's very proper criticism. But if rigid gears shows no tendency to rise. The first two are by a well-known rigid gear manufacturer:—

(*a*) For a hospital ship, power constant 2.508.

(*b*) For torpedo-boat destroyers, power constants 1.52 high-pressure and 0.51 low-pressure. In this case the centres may have been spread due to the turbine design, but I do not know that this was so.

(*c*) Proposed land gear, power constant = 1.605.

The power constants for proposed rigid gears appear to fluctuate a great deal, suggesting trouble from the higher values.

Both Mr. Butler and Mr. Thorne think I have overestimated the effect of minute errors of alignment of rigid gears and that the teeth of such gears do bear evenly over their whole length. It was the conviction, arising from purely theoretical considerations, that minute errors of alignment would have serious effects which gave rise to the invention of the floating frame.† But this no longer only a theoretical conclusion. The Westinghouse Machine Company have built both floating frame and rigid gears and know the great care which must be exercised to attain as perfect alignment as possible in the latter. The gear case, after being rough machined, is left till the internal stresses have relieved

* Engineering, vol. ci, page 492.

† Engineering, vol. lxxxviii, page 378, Fig. 8, and text referring to it.

themselves as much as possible—still better results can be attained by annealing. The finishing cut is then made. No such precautions are necessary in building floating-frame gears. Again, they found that the greatest care was necessary in bolting down the gear-case; as predicted, the screwing down of a holding-down bolt could readily warp the casting and put the pinion and gear axes out of line. In small gears the difficulty can be largely met by bolting down the gear-case at three points and keeping all the rest of the surface free. But this is not practical in large marine gears. The experience of the Westinghouse Machine Company has convinced them of the great advantage of the floating frame in gears of over 400 h.p. Again, the high-power constant which can safely be adopted in floating-frame gears, as compared with the most experienced designs of fixed-bearing gears, is convincing proof of the accuracy of this conclusion.

Conclusive proof that gear teeth are bearing evenly over their whole length cannot be obtained by examination. If they have been bearing so hard at one part that they cut, the cutting will usually spread all along, and little can be learned unless the gear is stopped very soon after this action starts. Examination will show if a portion of any tooth has not been bearing at all; but if there is bearing varying from a light pressure at one end of the tooth face to a heavy pressure, but less than what will cause cutting, at the other end of the face, the teeth will soon be brightened all over. It cannot even be concluded that the teeth are bearing all along at the same time, as working of the ship's bottom or any straining action may cause the bearing portion to change. As I stated in a letter recently,* "When a grinder polishes a surface he only makes contact between the emery wheel and a small portion of the surface at one time." Improvement of pressure distribution cannot be made by giving the bearings ample clearance, as Mr. Thorne proposes. If a proper clearance is given, the oil film under pressure forms over a large arc of the journal. If this clearance is enlarged the effective arc is quickly restricted and the journal and brass come more nearly into contact. Further, no compensation of any value can be obtained through the oil film, for, as I showed in the recent letter just referred to, the thickness of the oil film is only very slightly responsive to change of total pressure from the journal. Besides, the change of bearing pressure which is supposed to alter the film thickness is due to bad distribution of tooth pressure. I need not re-discuss the question here.†

The only way to insure uniform tooth loading is to reduce redundancy as much as possible; or, as Sir William E. Smith stated it in the discussion, in terms of the condition laid down by my old teacher, Sir William Thomson (Lord Kelvin), "unnecessary geometrical restraints should be avoided in all mechanical constructions." This the floating frame does. I must strongly contradict Mr. Butler's statement that it is a complication; on the contrary, all the engineers of the Westinghouse Machine Company look on it as a great simplification of the construction and as making the proper action of the teeth a certainty.

Some of Mr. Thorne's criticism seems to proceed on the assumption that the torsional error of the pinion is the most serious one. I have examined the various errors at great length in my article "On Reduction Gears," and have shown, and experience confirms, that the alignment error is far the most serious in rigid gears, and that it does not exist in floating-frame gears. Far after that comes the cross-bending error and torsional error, usually in the order named if the pinion has two bearings, as in Mr. Thorne's Fig. 16 [page 333 *ante*]. If the pinion has three bearings, the order of importance of these two errors is reversed. If it be desired to reduce the torsional effect to a minimum the pinion should be driven by a flexible shaft attached under one of the helices, as was done in the Neptune after Mr. Westinghouse's suggestion to do this had been numerically investigated by Mr. Albert Kingsbury. Mr. Thorne's proposal in Fig. 12 requires four bearings for the pinion, and if he had adopted it in Fig. 16 it would very materially have increased the floor space and weight of his design. Nearly the same reduction of torsional error is accomplished by the floating frame with three bearings. But the numerical investigation I have given shows that the torsional error is so small that even were it obliterated the safe power constant would be only slightly raised; the anticipation that the adoption of the central drive, Fig. 12, would allow the same power constant as for floating-frame gears appears to me quite fanciful.

In Fig. 16 Mr. Thorne shows a very light design of gear, but the lightness is attained at a great sacrifice. The pinions have only two bearings each, which causes the cross-bending error to be very large and seriously limits the load which can be put on the gear. The spread of the bearings carrying the second reduction pinion is much increased, as the first reduction gear is inserted between the two helices; further, the pressures on the teeth of this gear wheel and the second reduction pinion are all upward or all downward. Both causes greatly aggravate the cross-bending error. Probably the limiting of this spread of bearings was the cause of so great reduction of the breadth of face of the second reduction pinion; and even at the width shown it will cause, I am confident, very poor distribution of pressure even over this narrow tooth face. I think there can be no doubt that, although the power constant is so low, the gear figured in Fig. 16 is much nearer the danger limit than the floating-frame gear with which he compares it. So far as safety—the most important consideration—is concerned, this re-establishes the third conclusion of my paper, which Mr. Thorne disputes, viz., "That the performance of gears of any design should be judged by the value of the power constant it will safely bear."

Of course, gears of either type, "floating frame" or "rigid," may be built with or without special regard to saving of weight and space. With these in view, the Westinghouse Machine Company have more recently built gears with much the same arrangement as Fig. 16, but with three bearing floating frames supporting each pinion. I did not mention this in my Naval Architects' paper, as none of these was in service when it was written. I now enclose a photograph [opposite] of one of these gears. It is of 3,400 h.p. at 3,740 r.p.m. of the first pinion. The weight, deducting the Kingsbury thrust block, the casing for which is cast on the gear case, is 34 tons. The overall dimensions in place are 9 ft. 8 in. fore and aft by 12 ft. athwartship, giving 116 sq. ft. The foot bolting to the ship's keelson is 8 ft. 6 in. by 10 ft. 6 in., giving 89.25 sq. ft. The reduction is from a turbine speed of 3,740 r.p.m. to a propeller speed of 72 r.p.m. If we raise the turbine speed to 3,860 r.p.m. to correspond to Fig. 16, the power is raised to 3,500 and the propeller speed to 74.3 r.p.m. Thus for 20 per cent. more power than Mr. Thorne's gear there is less weight and less space occupied; and since the helices are all about two diameters in length, with good bearing assured under all circumstances by the floating frames, the factor of safety will be much larger than can be obtained with the narrow tooth faces and two bearing pinions of Fig. 16, notwithstanding his low power constant. Therefore, as Mr. Thorne would require to increase very materially both his fore-and-aft length and his weight to attain an equal factor of safety, my fifth conclusion stands, viz., "Comparing gears of different types, with a given ratio of reduction, a rise in the safe power constant quickly reduces the weight per horse-power."

In reply to Mr. Sydney W. Barnaby, I can see no limits to the horse-power transmissible by a floating-frame or rigid gear except those arising from the size of parts which can be machined in any shop. I would have been glad to illustrate and describe the gears for the United States Scout cruisers, but the Westinghouse Machine Company's plans are confidential, and it was very properly requested from Washington that they should not be used.

Yours very truly,

JOHN H. MACALPINE.

5,537, Hampton-street, Pittsburgh, Pa., U.S.A.,
May 23, 1917.

* ENGINEERING, vol. cii, page 527.

† In a footnote to that letter 0.0007 is printed instead of 0.00007, but as it is the difference of two numbers which are also given, this should cause no difficulty.

METAL MELTING.*

By H. M. THORNTON, M.I.Mech.E., and HAROLD HARTLEY, M.Sc.

(*Concluded from page* 581.)

Red Brass.—We had occasion recently to carry out for a client a series of melts with a red brass containing about 2 per cent. tin in 60 lb. lots. Only three successive melts were made on each occasion. The average results are appended, together with the gas consumptions for melting yellow brass under the same conditions.

No. of Melt	1.	2.	3.
Weight of metal charged (in lb.)	60	60	60
Amount preheated	12	All	All
Gas.			
Consumption, cubic feet per lb. of metal melted	6.10	2.43	2.14
Calorific value, net	548 British thermal units per cubic foot.		
British thermal units per lb. of metal melted	3,256	1,297	1,142
Duration of heating (in minutes)	98	38	34
Pouring temperature		1,090 deg. C.	

Gas consumption (average for three melts), cubic feet, per lb. melted:
Red brass (pouring temperature, 1,090 deg. C.) .. 3.56
Yellow brass (pouring temperature, 990 deg. C.) .. 2.95

Analyses were made of the red brass prior to the first test melt and after the second melt; they are appended:

	Original Metal.	After 2nd Melt.
Tin	2.52	2.69
Zinc	9.85	9.50
Lead	0.19	0.35
Iron	0.05	0.25
Copper (by difference)	87.39	87.21

Zinc loss during two melts, per cent. original content = 3.56.

The preferential loss of zinc is thus seen to be small.

Gun-metal.—C. P. Karr† has given the results of a series of tests of gun-metal (88.10.2), carried out in connection with the Bureau of Standards, in which different manufacturers remelted a quantity of metal sent to them. The zinc loss was found to be inappreciable. Pouring temperature 1,100 deg. C. to 1,200 deg. C.

Copper.—From the results of the melting tests with this metal given below it will be noticed how important is the ability to load up the pot as much as possible. Materially better results were obtained when the charge was mixed scrap and ingots than when only sheet scrap was handled.

Melting of Sheet Copper Scrap.

No. of Melt	1.	2.	3.	4.
Weight melted (in lb.)	60	60	60	60
Weight preheated (in lb.)	28	All	All	All
Gas.				
Cubic feet per lb.	8.15	4.98	3.52	3.25
Net calorific value	518.4 British thermal units per cubic foot.			
British thermal units per lb.	4,197	2,564	1,812	1,673
Duration of heating (in minutes)	141	88	60	57
Pouring temperature		1,220 deg. C.		

Average for Four Melts.

Cub. ft. of gas per lb. metal melted = 4.98
B.Th.U. per lb. metal melted = 2568

The metal was cast in ingot chills. Subsequently these ingots were melted, with the addition of a little more sheet scrap. The melting results are given overleaf.

The markedly improved results obtained in this second series of melts indicate that the massive form of the metal is more suitable for melting in this type of furnace. Ability to pack the pot well is important if the most economical melting is desired.

To emphasize this point we draw attention to the following table. The melts were made on three different days, starting with the furnace cold in each case, the charges being:—

A. Copper sheet scrap.
B. Copper ingots and sheet scrap.
C. Copper allowed to solidify in the crucible after the previous day's melt.

	A.	B.	C.
Weight melted (in lb.)	60	68	68
Weight preheated (in lb.)	28	24½	nil
Cubic feet gas per lb.	8.15	7.94	7.59

Thermal Efficiency.—An approximate idea of the efficiency of the furnace will be of interest, and also it may enable us to compute within reasonable limits the extra consumption allowance which must be made when high pouring temperatures are required for any particular purpose; moreover, the result indicates the degree of success that has been attained in the construction of the class of furnace which we are discussing. Using the data given above for copper, the following results are obtained:—

Fifth Melt.

Gas consumption per lb. of metal melted = 2.45 cub. ft.
Temperature ... 36 deg. F.
Pressure ... 4¼-in. water.
Barometer ... 761.1 mm.
Thus gas consumption per kg. molten metal corrected to 0/760 = 5.39 cub. ft.
Net cal. val. of gas ... = 133.6 K.C.U. per cubic foot.
Thus heat supplied to furnace per kg. copper melted ... = 709 K.C.U.

Assume:

Specific heat of copper 14 deg. C. to 1,084 deg. C. = 0.11 K.C.U. per kg. per deg. C.
Specific heat of copper 1,084 deg. C. to 1,210 deg. C. = 0.16 K.C.U. per kg. per deg. C.
Latent heat of fusion of copper ... = 43 K.C.U. per kg. per deg. C.
Thus total heat supplied to the copper ... = 181 K.C.U.

Therefore efficiency $= \frac{181}{709} \times 100 = 25.5$ per cent.

The over-all efficiency for the six melts quoted = $\frac{2.45}{3.66} \times 25.5 = 17.1$ per cent.

This latter figure will rise gradually as the number of melts is increased.

From the results given for brass and combined with those obtained with copper, it is possible to arrive at an estimate of the additional gas consumption necessary to heat the brass to a considerably higher temperature. If it be assumed that the specific heat of brass is the same as that of copper (at ordinary temperatures this is very nearly so), and that the heat allowance to be made for the liquefaction of the brass is 38 K.C.U. per kilogram; then the steady state efficiency during the fifth brass melt (metal poured at 990 deg. C.) = 30 per cent.

Over-all efficiency for six brass melts (990 deg. C.) = 21.3 per cent. Thus we can assume for six consecutive melts:—

Temperature Attained. Deg. C.	Over-all Efficiency. Per cent.
990	21.3
1,090	19.4
1,190	17.2

From this we see that to get the brass to 1,090 deg. C. would require about 1,456 British thermal units per lb. (364 K.C.U.), or approximately 253 British thermal units more than was expended in the test given previously, *i.e.*, an additional 0.45 cub. ft. of gas per lb. of metal on the six melt basis. With an increased number of melts the actual extra gas used on the basis of the average for the day's work decreases, but still remains about 20 per cent. more than that required for 990 deg. C.

We have not been able to secure satisfactory data

* Paper read before the Institute of Metals, slightly abbreviated.

† American Institute of Metals, September, 1916.

concerning coke consumptions for the melting of copper, but are informed that 0.5 lb. of coke per lb. of metal represents an average figure for brass melting. If the net calorific value of the coke = 12,000 British thermal units per lb., then 6,000 British thermal units are employed per lb. of brass melted.

With 560 British thermal units gas the six melts were done at an average consumption of 2.25 cub. ft. per lb. gross, equal to 1,200 British thermal units per lb. of metal melted, from which it would apper that, roughly, the thermal efficiency of the gas furnace is about five times that of many coke furnaces, the latter converting approximately 4 per cent. of the available energy into useful work.

Gillett* states that in the melting of all non-ferrous alloys 90 per cent. to 95 per cent. of the heat units in the fuel do no useful work; he also mentions reports of fuel efficiencies varying from 1½ per cent. to 16 per cent. received during his inquiry.

Advantages of Preheating.—The results which we have given were obtained in a gas-fired furnace, with an arrangement for preheating the metal prior to charging, and for preheating the air supply before it is admitted to the blast burner. A simple calculation shows that preheating can effect a considerable saving of fuel, and that if the brass and air are preheated to the same temperature prior to admission to the furnace proper, a considerably greater regeneration results from the brass than from the air. Thus assuming the metal was to be poured at 1,000 deg. C., if the brass be preheated to 600 deg. C. roughly a 40 per cent. saving can be effected, whereas if the air were preheated to the same extent—and this offers great difficulties—the saving would be 20 per cent., neglecting the effect on the temperature attained in the combustion zone.

Copper Melting — Ingot + Scrap.

No. of Melt	1.	2.	3.	4.	5.	6.	7.
Total charge (in lb.)	68	68	68	68	68	68	68
Including scrap	1 lb. 9 oz.	1 lb. 10 oz.	3 lb. 1 oz.	1 lb. 10 oz.	6 lb. 15 oz.	10 oz.	5 lb.
Amount preheated	8 lb.	All	All	All	All	All	All
Gas.							
Cubic feet per lb.	8.23	3.12	3.10	2.81	2.45	2.47	2.23
Calorific value, net		530.3	British thermal units per cubic foot.				
British thermal units per lb.	4,295	1,629	1,618	1,467	1,278	1,289	1,163
Duration (minutes)	151	54	56	46	42	43	42
Pouring temperature				1,210 deg. C.			

Summary.

	Cubic feet per lb. Melted.	British thermal units per lb. Melted.
Average for 5 melts (Nos. 1, 2, 3, 4 and 7)	3.90	2,034
,, 6 melts (Nos. 1, 2, 3, 4, 5 and 7)	3.66	1,908
,, 7 melts	3.49	1,820

In the case of copper, the saving to be anticipated from preheating the metal to 800 deg. C., with a pouring temperature of 1,250 deg. C., is 47 per cent.

In actual practice we have obtained with brass the following results, pouring at about 1,000 deg. C. :—

No. of melts made consecutively	4	6
	Gas Consumption per lb. of Metal Melted.	
No preheating (*a*)	3.10	2.91
Brass preheated (*b*)	2.72	2.48
Brass and air preheated (*c*)	2.42	2.17

The actual consumptions for the fourth melts being :—

(*a*) 2.52 cub. ft. per lb.
(*b*) 1.99 ,, ,,
(*c*) 1.66 ,, ,,

Thus it is evident that for brass melting the most suitable type of furnace to be employed will depend upon the number of melts required daily, as when only a few melts are required the additional capital cost involved in the introduction of the preheating device may not be compensated for adequately by the gas saved. It will hardly be necessary to mention that if the furnace is suitably constructed the metal and air are both preheated to a considerably higher temperature in melting copper or cupro-nickel than when melting brass.

Life of Pots.—A well-made graphite crucible is capable of withstanding very sudden temperature changes to an almost surprising extent. W. F. Downs† stated that he heated a small crucible to 1,400 deg. C. and plunged it into cold water, and repeated this treatment 12 times before any change could be detected in the note produced on tapping it with an iron bar; after repeating this treatment 20 times the note was practically gone. He makes the further statement that in actual commercial use for melting purposes a crucible has been known to stand from 80 to 100 charges in melting copper or a similar metal. This view is largely endorsed by F. Cirkel in his monograph on graphite. The latter says: "They stand in the manufacture of brass from 35 to 45 melts, when clay crucibles only stand from 4 to 6 melts. The very best crucibles made of the very best quality crystalline graphite can stand from 50 to 60 and even 70 heats of brass, a crucible made of amorphous or dense graphite will only stand from 6 to 8 heats. After every heat attention must be given to the removal of slag." These statements refer to coke-fired furnaces, and although many melters only claim about 30 melts per pot it is an indication at least that, given favourable conditions, much better results are obtainable. The care adopted in the use of a crucible, and especially during the initial melt, is of outstanding importance. Barton states* that in making cartridge brass the average life of a pot (200-lb. size) is 25 heats, but is much shortened by ill-fitting tongs, excess of fluxes, "soaking" in the furnace, excessive furnace temperatures, wet or sulphurous fuel, and carelessness in stirring and handling.

Gillett† emphasises the importance of using properly-fitting tongs, and appears to prefer the "Grab" to the "Pinch" type. He draws attention to the danger of wedging the crucible full of cold ingots or scrap, which on heating expand more than the pot and may cause splitting. In coke furnaces he says crucibles may be badly injured mechanically by carelessness in poking the fire or in knocking off slag and clinkers. Excessive temperature changes of the pot should be avoided; if the best results are to be obtained they should not be allowed to cool too much between melts.

It is often stated to be noteworthy that the best results with regard to pot life are obtained in the brass-rolling trade, and this is attributed to the fact that those users have available and employ a good means of drying their pots prior to use; the pots being stored on top of the heat-treatment furnaces, where they are kept dry. Probably all users take care to dry their crucibles, but it is doubtful whether the same attention is paid to the annealing—gentle heating up to a red heat before charging for the first melt. A little trouble taken at this stage will be well repaid later. Even though the preparation of crucibles may have been sufficient to avoid a "bumped" pot, the danger of the formation of small hair cracks in the pot has to be avoided if the best results are to be obtained. After the first melt has been executed satisfactorily, the crucible would appear to be capable of withstanding drastic heat treatment. It is not in our opinion, however, desirable to take liberties at any time, and we would advise always gentle heat treatment during the first melt of the day, as although the pot may appear to be unaffected by heating it up very rapidly, there is always a danger of forming hair cracks.

In a gas-fired furnace the abrasive action of the solid fuel is eliminated, the direction of flow of the gas stream is under better control, the sulphur content of the fuel is very small (about 30 grains per 100 cub. ft.), there is no fire to poke, and clinkers have not to be removed from the outside of the pot, so that it is not surprising that long pot lives can be obtained, especially in the absence of fluxes or with a flux which does not attack the crucible walls viciously. In a gas-fired furnace doing 5 or 6 melts a day no difficulty should be found in obtaining 45 to 50 melts out of a 70-lb. pot, thus comparing very favourably with the coke-fired furnaces. When a furnace is run full time, doing 15 to 20 melts per day—and with a gas-fired furnace this is obtainable—a considerable increase in the number of melts per pot results. If the use of a flux does not determine the length o life of a pot, we should expect a 50 per cent. increase in the pot life when a gas-fired furnace is substituted for one coke-fired—provided, of course, that the melter shows a reasonable amount of care in handling and loading the crucible.

Increased Output.—On the basis of the figures given above for brass melting it follows that the average time for the actual melting operation is, for 12 melts of 68 lb. each, 39 minutes, and for 15 melts 37 minutes, making no allowance for the time required to pour. Under similar conditions 55 minutes would probably represent an average for many coke-fired furnaces. With the gas-fired furnace cited above the average time for melting can be decreased by 3 to 5 minutes by working at a higher consumption without a decrease in the thermal efficiency of the appliance. To claim a saving of time for melting of 25 per cent. with a gas-fired furnace, against ordinary practice with a solid fuel furnace, in the melting of brass would not be excessive.

In conclusion, we wish to state that the results for gas consumptions which we have quoted have all been obtained in the works of the Richmond Gas Stove and Meter Company by members of their staff, and are not to be regarded as representing "works practice," as ordinarily understood, by which the furnace is debited with the mistakes of the melter. On the other hand, the work has been carried out under such conditions that it would not be unreasonable to expect others in charge of the furnaces to obtain results of the same order. Once the furnace is set going the only duty devolving on the melter is to see that he keeps as much metal in the pot as possible and ensures that there shall be an ample, although not excessive, supply of metal in the preheating chamber; the charges there should be arranged, of course, so that the metal just before it is transferred to the crucible is in the hottest portion of the chamber. Above all, avoid the waste of time; if the gas consumption is about 3 cub. ft. per hour per lb. of brass in the charge to be melted, or even more, it will be obvious that 10 minutes wasted means that the average consumption for that particular melt is up by 0.5 cub. ft. per lb., not to mention the possibility of an increased zinc loss, especially in the later stages of the process. For obvious reasons more constant supervision is desirable in brass melting than in the longer processes of melting copper or cupro-nickel. Probably the manufacturer will be served well if he arranges a bonus for low consumption on the basis of the output of castings, as in that way he provides a certain amount of protection against cold metal being supplied.

The authors wish to acknowledge the facilities given by the Richmond Company, Warrington, and the assistance of their Research Department in the compilation of many of the particulars given in this paper.

* *Loc. cit.* See page 581 *ante*.
† *Iron Age*, May 24, 1900, page 5.

* *Loc. cit.* See page 581 *ante*.
‡ *Loc. cit.* See page 581 *ante*.

APPENDIX.

Description of Furnace.

The metal melting referred to in this communication has all been carried out in a Richmond 70-lb. crucible furnace of the preheating type. The gas and air mixture is admitted through a suitable blast burner and the lower portion of the combustion chamber, and is burnt in the annulus between the crucible and the furnace wall. The gases after travelling around the pot are directed through the metal preheating chamber, and then pass on to the air pipes and finally to the flue. This arrangement enables a high degree of preheat of the metal to be obtained.

The top of the metal chamber is on a level with the top of the pot chamber and is closed by a pair of lids. With this construction the operator has not to lift his metal above the foundry floor level, and the transference of preheated material to the crucible is done with ease.

The lower portion of the wall of the combustion chamber is constructed of suitably-shaped blocks of a specially refractory nature to enable greater resistance to be offered to the combined action of high temperatures and spilt metal. The bottom of the chamber can be removed simply for the recovery of spilt metal.

COLONIAL ENGINEERING PROJECTS.

We give below a few data on several Colonial engineering projects, taken from *The Board of Trade Journal*. Further information on these projects can be obtained from the Department of Commercial Intelligence, 73, Basinghall-street, E.C. 2.

Australia.—The issues of *The New South Wales Government Gazette* of March 23 and 30 contain notices to the effect that licences have been granted by local authorities for the erection of pumps and the construction of dams in the State. Six pumps are to be erected and a dam built on Toongabbie Creek, St. John, Cumberland; a pump is to be erected and a dam built on the Cabramatta Creek, St. Luke, Cumberland; and pumps are to be erected on the South Creek, Londonderry, Cumberland, the Darling Mill Creek, Field of Mars, Cumberland; and on the Murrumbidgee River, York, Beresford. It is stipulated in the licences that a screen or rose with openings not more than ¼ in. wide is to be permanently fixed to the inlet end of the suction pipe of the pumps. With reference to the formation of an Australian company, known as the Amalgamated Zinc (De Bevay's), Limited, with a capital of 1,000,000*l.*, for the production of zinc by the electrolytic process, and for manufacturing high-grade spelter in Tasmania, it appears from a Special Act of the Tasmanian Parliament (No. 45 of 1917), a copy of which has been received at the Department of Commercial Intelligence, that the company has decided to establish works near Hobart for the electrolytic treatment of zinc concentrates. Under the powers of this Act it has been arranged to lease about 77 acres of Crown land at Risdon, on the river Derwent, to the company as a site for its works; the Act also provides for a new jetty and ferry terminus being constructed adjacent to the site. The State Hydro-Electric Department has undertaken to supply the company with power aggregating 50,000 h.p. from the department's Great Lake plant, of which not more than 40,000 h.p. is to be utilised in the production of electrolytic zinc; the remaining 10,000 h.p. is to be used in the manufacture of other electro-chemical or electro-metallurgical products. The Department of Commercial Intelligence is in receipt of a copy of the Mining Act, 1917, of Tasmania (No. 62 of 1917), being an Act to consolidate and amend the law relating to mines and mining, and for other purposes. This Act, which was assented to on February 23, and deals, *inter alia*, with prospectors' licences, miners' rights, licences to search for coal or oil, water and timber rights, the encouragement of mining, &c., may be consulted by British firms interested at the Department of Commercial Intelligence.

Directory and Chronicle for China, Japan, &c.—This directory for 1917, which is issued at the price of 10s. net by the Hong-Kong Daily Press, Ltd., Hong-Kong and 131, Fleet street, E.C. 4, covers the whole of the Far East, including Siam, Netherlands India, Borneo, the Philippines. It opens with an almanac stating the notable events in the history of the Far East, with the text of the most important treaties concluded with the countries of Eastern Asia, followed by the various customs tariffs, trade regulations, &c. Then follows the directory of the different ports and cities of the Far East, a brief history and description of each port and city, with its surroundings, being given. A large number of very clear plans are added. The book ends with an alphabetical list of over 200 pages, containing the names of residents in the Far East. It is carefully got up, and is an interesting guide to the part of the world with which it deals.

THE ARRANGEMENT OF MACHINE SHOPS.—No. XIV.

By JOSEPH HORNER.

WE propose now to make a selection from American shops, including the lay-out of machine tools and the constructional details of the buildings. These will afford examples of standardisation as carried out by Messrs. Westinghouse, Church, Kerr and Co., of 37, Wall-street, New York, to whom our acknowledgments are due for the drawings from which the following illustrations have been prepared.

The movement in favour of the adoption of standardised details in shop buildings, though so recent, is extending rapidly, and some remarkable records in quick erection might be given. American shops are generally constructed after different patterns from ours. The high-pitched ridge roofs are not nearly so frequent as are those which have only a few degrees of slope. The extreme cold of the winters renders heating systems essential. Electric driving is more common. For these and other reasons the examples to be illustrated should afford an instructive selection.

The American system of standardisation of factory buildings combines aggregations of fixed elements, of similar units, of rigid details, with elasticity in the working out of individual contracts. The shops are multiples of radical elements, repetitions of self-contained constructional styles of designs already in existence, to be submitted *en bloc* to the requirements and the dimensions suitable for any one particular class of shop for which a tender is invited. These include a good variety in designs from which alternatives are offered for the walls, the roofs, the floors. Also for ground-floor shops of both light and heavy types, either without crane service, or to carry overhead travelling cranes, and with a range in spans and heights; and, again, the shops with floors—the storied buildings. Provision for heating and for ventilation is commonly included, not as an addition, but as an integral portion of the structure, determined and designed before its erection. But however widely the details of shops may vary, these details are standardised, ready worked out for all anticipated requirements, and therefore no time is lost in getting out initial calculations, or in obtaining particulars and estimates of materials which may or may not happen to be immediately available, and no odd sizes of sections and scantlings to be worried about or cause delays. Everything has been foreseen and forestalled, and the tendering firm is ready to commence building as soon as the design is accepted and the order given.

The views Figs. 107 to 109 illustrate the shops of the Chicago, Burlington and Quincy Railroad Company, of West Burlington, Iowa, selected as being representative of the general lay-out of ground-floor shops. Fig. 108 is merely a key plan of a large block of buildings which includes machine and erecting shops. They are 795 ft. long by 313 ft. in total width. Four bays include two machine shops for light and heavy tools respectively, an erecting shop, and a south shop, without tools, which last is flanked by a yard served by a continuous gantry carrying a 10-ton crane. The areas of the shops are only divided off from each other by the roof columns of rolled joists. The walls are of concrete up to the line of the lower window-sills. Above that line, and pierced with many windows, the walls are of 8-in. vitrified hollow tiles, giving a cheaper construction with less heat loss than bricks.

The separate bays are roofed as though they were distinct buildings, as shown in Fig. 109. The main or erecting bay has a very flat ridge roof with a central louvre, and a continuous skylight which affords enough illumination without regarding that supplied by the windows in the distant concrete walls. The south shop and the heavy machine shop are lower, measuring 31 ft. and 36 ft. respectively to the under side of the roof girders, the central bay being 50 ft. high. The roofs of these are of the flat ridge design, but the slopes are unequal. The half with the greater slant is a single saw-tooth element, having a continuous steel sash along its steeper face. The glass on one roof faces north, that on the other south. The machine-shop for light tools has a similar roof, with a continuous sash giving north light. This shop measures 23 ft. high below the roof beams. Each shop except this one is provided with overhead travelling cranes. The main erecting bay, which is 100 ft. wide, measured from centre to centre of columns, has cranes of two powers, one being of 125 tons capacity, and having also two auxiliary hoists of 15 tons load, with its rails carried high up, the other, of 15 tons, is lower. The remaining three bays are each 70 ft. wide. The south shop, occupied with cylinder and other preparatory work, and the heavy machine shop are furnished with 15-ton cranes.

The erecting shop—the principal bay—is served by three rows of rail tracks which connect it with the area covered by the gantry at the eastern end. This, with its 50-ton crane, occupies the entire

Fig. 107.

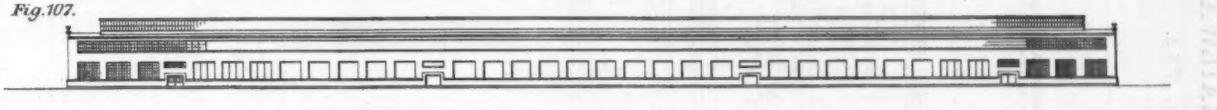


Fig. 108.

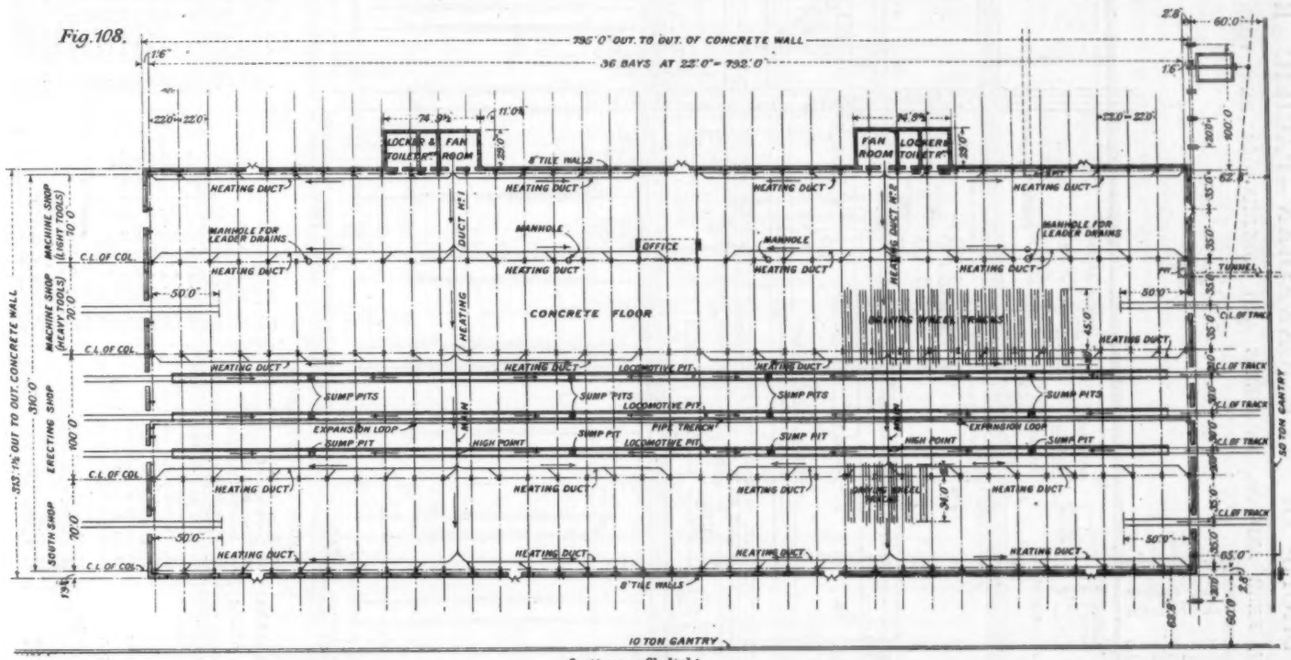
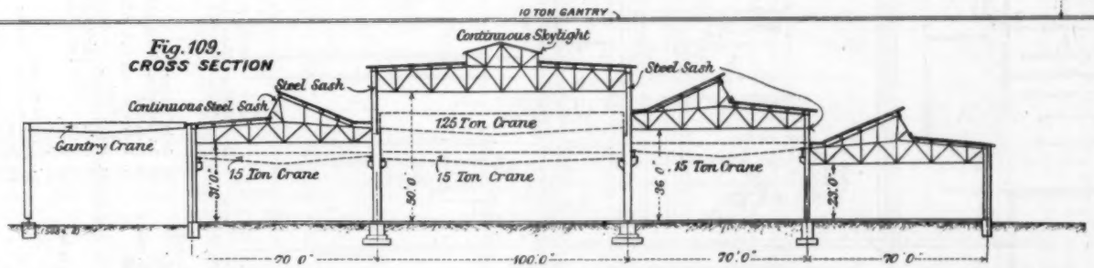


Fig. 109.
CROSS SECTION

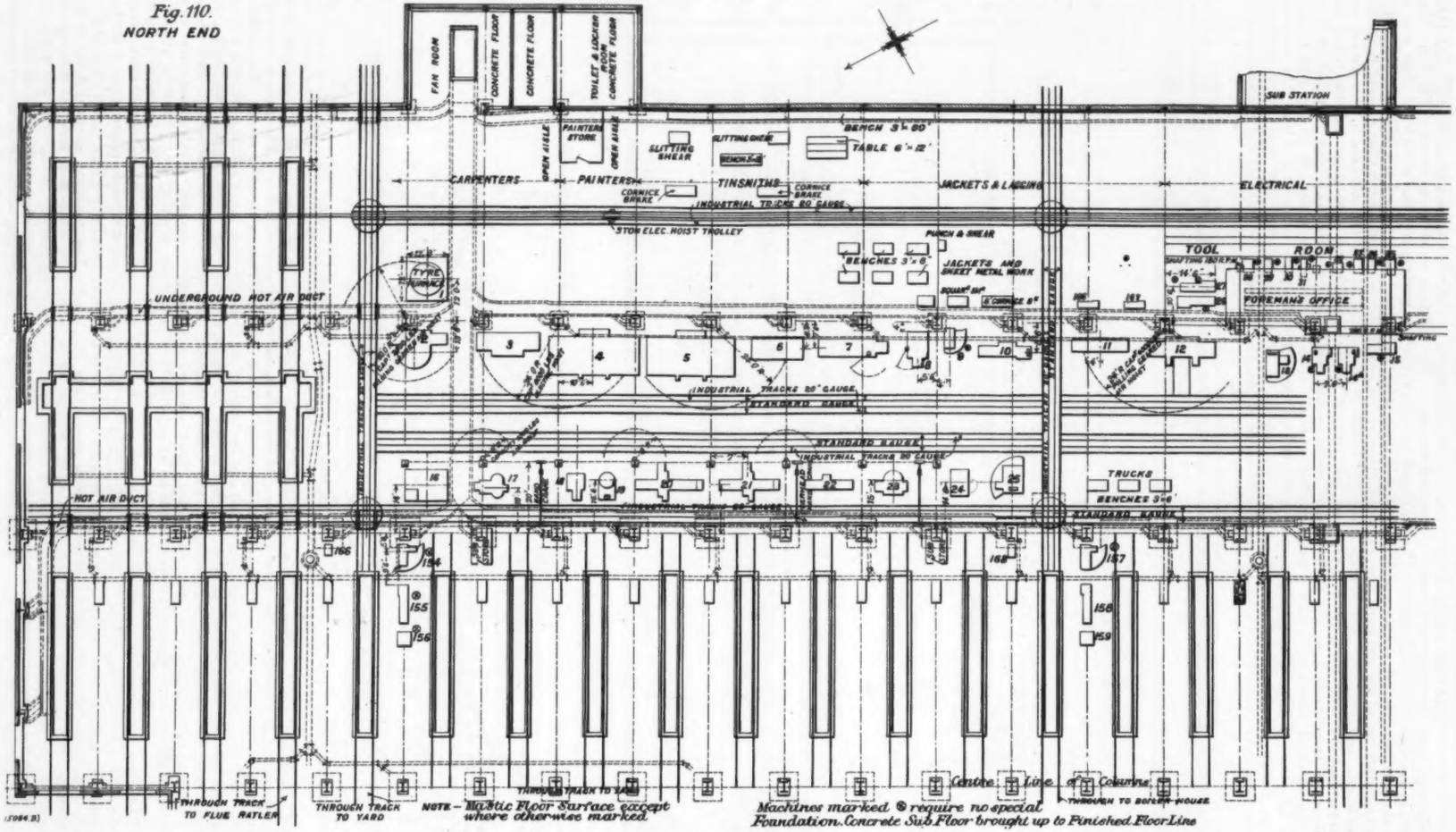


FIGS. 107 TO 109. MACHINE AND ERECTING SHOPS OF THE CHICAGO, BURLINGTON AND QUINCY RAILROAD CO., WEST BURLINGTON, IOWA, U.S.A.

THE OGDEN MACHINE SHOPS OF THE CANADIAN PACIFIC RAILWAY.

MESSRS. WESTINGHOUSE, CHURCH, KERR AND CO., ENGINEERS AND CONSTRUCTORS, NEW YORK, U.S.A.

Fig. 110.
NORTH END



NOTE—Mastic Floor Surface except where otherwise marked.

Machines marked ® require no special Foundation. Concrete Sub Floor brought up to Finished Floor Line

TABLE OF REFERENCES.

1. Tyre furnace.
2. Boring mill.
3. 600-ton hydraulic press.
4. 90-in. heavy wheel lathe.
5. 90-in. heavy wheel lathe.
6. Crank-pin turning machine.
7. Axle lathe.
8. Morton draw cut shaper.
9. Radial drill.
10. 36-in. by 16-ft. engine lathe.
11. 400-ton wheel press.
12. 42-in. steel tyre wheel lathe.
13. Radial drill.
14. 24-in. shaper.
14A. 24-in. shaper.
15. 18-in. by 16-in E. lathe, bolts.
16. Cleaning table.
17. 15-in. slotter.
18. H. D. drill, heavy, 36-in.
19. 36-in. plain vertical drill.
20. 36-in. by 36-in. by 10-ft. planer.
21. 30-in. by 30-in. by 8-ft. planer
22. Horizontal boring mill.
23. 42-in. boring mill.
24. Triple bolt cutter.
25. 72-in. radial drill.
26. 20-in by 8-ft. lathe.
27. 16-in. by 7-ft. engine lathe.
28. 26-in. drill.
29. 16-in. drill.
30. Hack saw.
31. Grindstone.
32. Emery wheel.
33. 4-in. by 26-in. wet grinder.
34. Drill grinder.
35. Die grinder.
36. 14-in. by 7-ft. 6-in. engine lathe.
37. 14-in. by 7-ft. engine lathe.
38. 20-in. shaper.
39. 2A Universal milling machine
40. 36-in. drill.
41. Universal tool and grinding machine.
42. Crank shaper.
43. 30-in vertical turret lathe.
44. 36-in. vertical turret lathe.
45. Forge.
46. Forge.
47. Power hammer.
48. Tool-tempering furnace.
49. Blower.
50. Travelling head shaper.
51. 60-in. radial drill.
52. 18-in. by 6-ft. engine lathe.
53. 16-in. by 6-ft. ditto.
54. 18-in. by 8-ft. ditto.
55. 18-in. by 8-ft. ditto.
56. 20-in. by 8-ft. ditto.
57. 20-in. by 8-ft. ditto.
58. 20-in. by 8-ft. ditto.
59. 20-in. by 8-ft. ditto.
60. Auto stud machine.
61. 16-in. drill.
62. Two-spindle rod drill.
63. 36-in. by 36-in. by 8-ft. planer
64. 36-in. by 36-in. by 10-ft. planer
65. Vertical milling machine.
66. Shaper, 24-in. by 30-in.
67. Centring machine.
68. 4¼-in. Gisholt lathe.
69. 3A W. and A. turret lathe.
70. Herbert 2½-in. by 30-in. turret lathe.
71. 1¼-in. Herbert turret lathe.
72. Shaper, 24-in. by 30-in.
73. Shaper, 24-in. by 30-in.
74. 15-ft. slotter.
75. Vertical drill.
76. Drill.
77. Cotter drill.
78. Link grinder.
79. Bush press.
80. 60-in. radial drill.
81. 36-in. by 14-ft. engine lathe.
82. 30-in. by 12-ft. ditto.
83. 30-in. by 12-ft. ditto.
84. 26-in. by 12-ft. ditto.
85. 24-in. by 10-ft. ditto.
86. 20-in. by 8-ft. ditto.
87. 26-in. by 12-ft. ditto.
88. 16-in. drill.
89. 16-in. drill
90. Centring machine.
91. Pump rack.
91A. Pump rack.
92. Bush press.
93. 26-in. F. B. drill.
94. 18-in. by 10-ft. engine lathe.
95. 16-in. by 8-ft. engine lathe.
96. Guide bar grinder.
97. Piston rod grinder.
98. 20-in. by 8-ft. engine lathe.
99. 26-in. by 10-ft. ditto.
100. 20-in. by 12-ft. ditto.
101. 18-in. by 10-ft. ditto.
102. 14-in. by 10-ft. ditto.
103. 24-in. by 10-ft. ditto.
104. 20-in. by 8-ft. ditto.
105. 24-in. by 8-ft. ditto.
106. 14-in. by 8-ft. ditto.
107. 14-in. by 8-ft. ditto.
108. 18-in. by 10-ft. ditto.
109. 18-in. by 10-ft. ditto.
110. 36-in. by 36-in. by 6-ft. planer
111. Shaper, 24-in. by 30-in.
112. Shaper, 24-in. by 30-in.
113. Boring mill.
114. Vertical miller.
115. 24-in. drill.
116. Shaper, Morton draw cut and travelling head, 48-in.
117. 42-in. boring mill
118. 16-in. drill.
119. Hack saw.
120. Boring mill.
121. 66-in. radial drill.
122. 20-in. brass lathe.
123. 16-in. brass lathe.
124. Brass lathe, 20-in. by 7-ft. 6-in.
125. 20-in. brass lathe.
126. 16-in. brass lathe.
127. Valve miller.
128. Cock grinder.
129. Buffer grinder.
130. Hack saw.
131. Nut facer.
132. Centring machine.

THE OGDEN MACHINE SHOPS OF THE CANADIAN PACIFIC RAILWAY.

MESSRS. WESTINGHOUSE, CHURCH, KERR AND CO., ENGINEERS AND CONSTRUCTORS, NEW YORK, U.S.A.

Fig. 111.

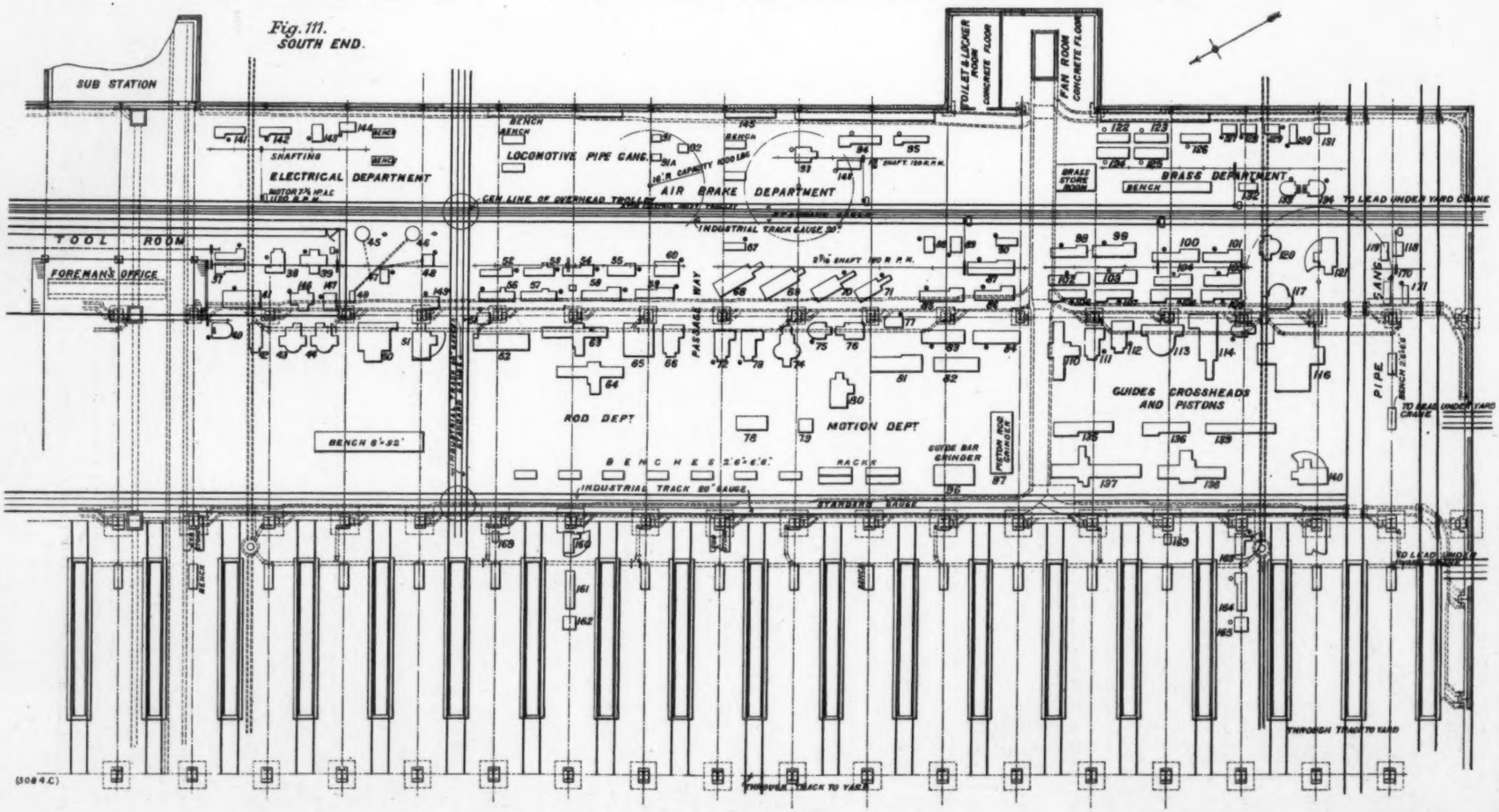


TABLE OF REFERENCES.

133. 30-in. vertical drill.
134. 36-in. vertical drill.
135. 32-in. by 16-ft. engine lathe.
136. 30-in. by 12-ft. engine lathe.
137. 48-in. by 48-in. by 16-ft. planer.
138. 36-in. by 36-in. by 10-ft. planer.
139. Break lathe.
140. Universal radial drill.
141. 16 - in. by 6 - ft. engine lathe.
142. Old lathe.
143. 16-in. drill.
144. Buffer and emery grinder.
145. Pump test rack.
146. 2A Universal milling machine
147. Sellers cutter grinder.
148. Cylinder boring machine.
149. Disc grinder.
150.
151.
152.
153.
154. 36-in. radial drill.
155. 16-in. by 8-ft. engine lathe.
156. 4-in. by 26-in. grinder.
157. 36-in. radial drill.
158. 16-in. by 8-ft. engine lathe.
159. 4-in. by 26-in. grinder.
160. 36-in. radial drill.
161. 16-in. by 8-ft. lathe.
162. 4-in. by 26-in. grinder.
163. 36-in. radial drill.
164. 16-in. by 8-ft. lathe.
165. 4-in. by 26-in. grinder.
166. 16-in. portable bolt lathe.
167. 16-in. portable bolt lathe.
168. Emery grinder.
169. Emery grinder.
170. 12-in. pipe machine.
171. 4-in. pipe machine.

width of the shop at that end. The rail tracks enter within the heavy machine shop, and into the south shop, after which the cranes take charge of the work. In the erecting shop are three locomotive pits, which run along its entire length and have drainage sumps at intervals. Near the eastern end of the heavy machine shop a number of driving-wheel tracks are located. The heating pipes follow the walls and the roof columns, whence ducts distribute the warm air on the plenum system. The underground heating ducts are constructed of concrete and tile, with reinforced concrete covers. The fan rooms are located outside the north wall. Cast-iron radiation is used, heated with exhaust steam from the power-house at about 2 lb. pressure. The floors of the shops are of concrete.

This is a typical standardised building of the one-floor design. Everything is arranged in straight lines and is in direct communication with the outside yard. Each shop is self-contained, with dimensions adapted to the kind of work to be done in it. Each is built up of unit sections of columns and roof, to which additions can be readily made. The group of shops covers a vast unobstructed area having abundant illumination, with no useless and costly walls. Work is done in comfort, and there is no hindrance to its progress, no going back on tracks or awkward corners to negotiate.

The internal arrangement of the Ogden machine shops of the Canadian Pacific Railway, built by Messrs. Westinghouse, Church, Kerr and Co., is given in Figs. 110 and 111, on pages 606 and 607,

and comprises the south and north shops respectively. The buildings are served and are connected with the outer yard by tracks of standard gauge, and between these are two industrial railways of 20-in. gauge, one rail of each standard track forming also one rail of the narrow-gauge track. Portions of the shops are also covered by an overhead system of rails.

Here, as is now usual, the machines are grouped round those particular departments of work for which they are selected. All the heavy tools have individual motors, smaller ones are driven in groups. Both direct and alternating currents are used. Pipes and ducts for warming with hot air are distributed about. The lower side of the building is occupied with a series of engine pits, each with its track leading to the yard outside and passing between the columns. The walls are constructed of concrete, the sub-floor is of concrete, covered generally with mastic.

Taking the south end of the shops first, Fig. 110, and entering at the right hand, the pipe department occupies the first area. It is provided with benches, pipe machines, a hack saw, and a drilling machine. These tools are driven by one line shaft from a 5½-h.p. motor. The pipe fittings are stored in a rack alongside the wall.

Beyond this the first large department is that which is occupied with the tooling of guides, crossheads and pistons. This includes lathes, planers, shapers, boring mills and drills. All the large machines are provided with their individual motors, and several of these are of great power, if we contrast it with the power that would have been allowed a few years ago. There is a piston-rod grinder with a 30-h.p. alternating-current motor, three planing machines take 15 h.p. each; a vertical miller and a break lathe each absorb as much, while other machines have motors of 10 h.p. For the group of 12 engine lathes one motor of 20 h.p. suffices. These are served by a line shaft of $2\frac{7}{8}$ in. in diameter, making 180 r.p.m.

Adjoining this area, and adjacent to the shop wall is the brass department, where 13 machines are driven from $1\frac{15}{16}$ in. shaft at 180 r.p.m., actuated by an alternating-current motor of 10 h.p. A vice bench and a store room are included in this department. Adjacent is the fan room, whence the air is supplied for the heating pipes, and also a toilet and a locker room. Tracks both of standard and narrow gauge run along the centre of the span between the brass department and the lathes in the guides, crossheads and pistons area. The second set of double tracks runs past the lower set of columns of the span adjacent.

Beyond the area where the guides, crossheads and pistons are dealt with a passage-way crosses the shop. Underneath it the main hot-air heating duct comes from the fan room, whence bends connect to the pipes that run longitudinally adjacent to the walls and to the rows of columns. On the other side of the passage-way a large area is occupied with the machines that deal with motor work, comprising common lathes and turret lathes, shapers, drills and grinders, together with sundry benches and work racks. Both systems of driving are also adopted here. The lighter machine tools are ranged adjacent to a line shaft, which is driven by a 20-h.p. motor. The department is flanked by the tracks on both sides, and a large central area is left clear. On the farther side of the upper track the air-brake shop is located. A 7½-h.p. motor drives four machine tools here. A long bench is ranged beside the wall, and two small ones are placed down in the open. Then the shop is traversed by another passage-way, and beyond this the connecting and coupling rods are dealt with. The same characteristics of the driving are repeated here as in other departments. Individual motors of 15 h.p. and of 10 h.p. and grouped shaft-driven machines served by one 15-h.p. motor occur. Benches, trestles and broad open areas are shown. On the other side of the track above are located the benches of the locomotive pipe gang. Just beyond the rail tracks cross the shops, being connected to the longitudinal ones with turntables. Farther on is the tool room, and a rather large space is available for local extension of plant or of tools. Then the foreman's office, and the electrical department. The machines in the tool room are shaft-driven. The forge and hardening shop for tools lies adjacent.

Passing to the next drawing, Fig. 111, which gives the lay-out of the north end of the Ogden shops, the foreman's office, included in both drawings, forms a connection with the termination of the drawing of the south end shop. Ranged on one side of the office are a number of small machine tools driven from the shaft last noticed, comprising drills, hacksaw and grinders. The electrical department is also included in this drawing to its termination, where it abuts on the areas where the jacketing and lagging are done.

Just here the shop arrangements are modified to suit a heavy class of work. Three sets of double rails are laid down instead of the one set which served the lower areas of the south shop, so that there are three standard tracks located not far apart, and six narrow-gauge tracks, and these are in addition to the double set which runs along the upper part of the shop. Over the area served by the three sets of rails the work of the wheels, tyres and axles is distributed. The machines comprise wheel lathes, an axle lathe, a tyre lathe, a crank-pin turning machine, and a hydraulic press. On the lower side of the tracks are machines for dealing with axle boxes. Several swinging jib cranes with air hoists serve the heavier tools. These have individual motors, some being of great power. A wheel lathe for steel tyres takes one of 25 h.p. A 90-in. wheel lathe has two motors, one of 50 h.p. for the cut, one of 5 h.p. for the traverse. Another 90-in. wheel lathe has three motors for its various movements. One of the planers takes a 20-h.p. motor. Above this area are spaces devoted to the sheet-metal workers, to the tinsmiths, the painters and the carpenters. Then another fan room, and beyond the tracks cross the shop and divide it from an erecting area provided with engine pits.

THE MOUNT WILSON OBSERVATORY.

THE publication of the annual report of Professor Hale, the director of the Mount Wilson Solar Observatory, is always a matter of importance, since it discloses the furthest point to which research has been able to carry the boundary of astronomical science, but at a time when the activities of many European observatories are restricted by the enforced curtailment of the respective staffs to meet the necessities of war, the history of that institution, remote from such disturbing influences, is particularly interesting. We are enabled not only to trace the progress made in penetrating the physical constitution of the sun and stars, but we must also admire the thoroughness with which the investigations are carried out. Plausible hypotheses designed to explain observed phenomena are submitted to test and examination in the true spirit of scientific inquiry. Problems connected with the evolution of the cosmos which a few years ago could not have been formulated are seen to be gradually unfolding in ordered succession, and each newly established fact is made a stepping-stone that permits further scrutiny into a scheme which will always offer new fields for exploration. The means for prosecuting inquiry, involving the improvement of existing, and the construction of new, apparatus, whose promise excites our enthusiasm and perhaps our envy, tell us of the accumulation of a new machinery that is being actively employed in advancing knowledge and satisfying curiosity.

The greatest of these new engines designed to throw more light on old problems and to solve new enigmas is the 100-in. reflecting telescope, which, after occupying the staff for several years, now happily approaches completion. The history of the mirror is the history of optical science in the long interval. It has taxed existing resources and encouraged further enterprise. Glass-founders had to learn the management of such huge masses of material, annealers had to overcome difficulties of no common order, opticians had to devise means of correcting unavoidable defects. Experience had to be gained in methods of grinding and figuring. The reward is now near at hand, for soon this Gargantuan eye will be at work exploring the heavens. It has satisfactorily passed the most critical examination. Special devices for detecting the minutest deviation from true figure had to be devised, and every day for many months the work of grinding and testing has been going on without hurry but without intermission. Critical tests on selected zones extending from the centre to the periphery show that the largest deviations between the observed and the theoretical focal length in any of the zones do not exceed 0.14 mm., or about one part in 92,000. The extreme care necessary to ensure this high standard of excellence could probably only have been secured in a workshop from which commercial influences were excluded.

The focal length of the mirror is approximately 507.5 in. and the clear aperture 101 in. The thickness of the finished glass at the edge is 12.75 in. and its weight is about 9,000 lb. The depth of the curve at the centre of the spherical mirror is about 1¼ in.; 35 gallons of water are required to fill this concavity. The distance between the paraboloid surface and the nearest spherical surface at the centre, where the difference is greatest, is only 0.001 in., yet the whole capacity of the instrument depends upon the accuracy with which the parabolising is accomplished.

The silvering was effected without any difficulty, or it would be better to say the whole of the difficulties had been foreseen and provided for. The entire operation was completed in fifteen minutes, but so large a surface required 32 oz. of silver nitrate. The burnishing of the silver film was done with a cushioned burnishing tool 34 in. in diameter, covered with six selected chamois skins.

The telescope will be provided with two convex mirrors, to which will be given an accurate hyperboloid form. One of these is 28.75 in. in diameter, 6½ in. thick; and its effect will be to increase the focal length of the mirror to 1,607 in. The second hyperbolic mirror, of slightly less area, but with shorter radius of curvature, will give an equivalent focal length of 3,011 in. All the subsidiary parts and mounting have necessarily to be constructed on an unprecedently large scale, but notwithstanding the drawbacks due to bulk and massiveness, good progress is being made. It has not been found feasible to assemble the various parts at the engineering shop, but many of the finished parts, after adequate testing, have been delivered at the observatory, though the difficulties of railway clearances, due to the size of the sections of the tube, &c., were not easily overcome. The dome under which the instrument will be housed is fully completed and painted, and fortunately could be utilised for the reception of the sectional parts on arrival at the summit of Mount Wilson. The electric wiring of the dome and instrument mounting is nearly finished. Some idea of the extent of the subsidiary apparatus required for the convenient working of such mammoth telescopes is given by the information supplied that no less than 35 electric motors are involved in the motions of the various parts of the telescope and dome, necessitating the construction of six switchboards. The whole of this intricate work has been carried out by the permanent staff of the observatory.

But though the attention of the scientific world has been centred on the construction of this unique telescope, and has followed its progress with sympathy, its erection by no means exhausts the energies of the staff entrusted with the work of design and construction. We hear of vertical spectographs mounted in pits sunk 35 ft. below the surface, of spectographs and heliographs embodying some new principle, of apparatus for examining Stark and Zeeman effects, and of various kinds of optical work, including the ruling of a diffraction grating covering a surface of 127 by 160 mm.

It would be a grateful task to linger over what has been accomplished by this powerful collection of tools and to indicate the programme outlined for the immediate future. But much of the success attained, as of the interest attaching to the researches in progress, appeals only to the trained physicist, and it is difficult to awaken enthusiasm in results whose importance and value lie in the attainment of minute accuracy. The last decimal place acquires a significance hitherto unknown. Advance in science lies in the detection and successful analysis of small residuals. The elimination of systematic errors ever taxes the ingenuity and the watchfulness

of the expert, and at Mount Wilson the zeal and the ability of the observer are exercised to their utmost limits; but we may not dwell on either the keenness or the necessity of the pursuit. The variation in the velocity in the rotation of the sun cannot be settled without eliminating the effects of the minute and long-unsuspected errors. The interpretation of the exquisite detail revealed in the vortex structure of parts of the solar surface can only be effected by delicate investigations in the laboratory, combined with searching theoretical discussion. When every result is entangled by so many perplexities, it is no slight triumph to have established beyond cavil that the magnetic axis of the sun does not coincide with the axis of rotation—in that respect resembling the earth.

Perhaps the researches designed to reveal the construction of the stellar cosmos and the scheme of magnificence on which it is built will appeal to a larger audience. To determine the distance of a star was a problem that long occupied and long baffled the astronomer, even when provided with adequate optical power. Till the staff of Mount Wilson pointed the way, a long and tedious process had been necessary to decide the distance of a star, but by some remarkable investigations it is now possible to obtain a star's parallax by a few simple measurements and calculations deduced from the photograph of its spectrum, with probably no greater error than by the old method. The collection of further data thus rendered possible confirms the existence of two groups of stars, giants and dwarfs, in which the masses of the individuals of one class are some six hundred times those of the other. No stars have been found which would tend to bridge this gap between the two groups. That a great cosmical fact lies concealed in this extraordinary division is certain, but we have not yet found the key to the riddle.

Nebulæ, those interesting bodies whose convolutions suggest internal motion, but whose study has hitherto brought little information, have been compelled to yield distinct evidence of rotation, albeit the period of complete revolution is of the order of 85,000 years. In a particular case a measurable spectrum, obtained after 80 hours' exposure, declared traces of a variable velocity at different distances from the centre, a variation that may be interpreted as due to the rotation of a solid body or as movement of matter along the branches of spiral convolutions. On plausible assumptions this nebula is distant from the sun some two thousand times that of the nearest fixed star. Its message, that is being read now, marks another forward step in the unknown.

The monochromatic photography of Jupiter and Saturn by the method of ray filters that transmit limited regions of the spectrum—a process that has been described in these columns—has been continued with marked success, and an analogous method has been adopted for determining star colours, which should have many fructiferous applications. It would be possible to refer to many other results connected with variable stars, with spectroscopic deductions, and the laboratory work, but we should still fail to do justice to the activity that Professor Hale inspires in every department, and to the rich harvest of results that is being so rapidly garnered. We can only tender to him and his staff our hearty congratulations on the achievement of so much original work.

THE CUNARD LINER "AURANIA."

SINCE the outbreak of war the Cunard Line has rendered extensive and important service to our own forces and those of the Allies by giving the use of a large proportion of their extensive fleet. No company had such a variety of ships, ranging from the leviathan of 26 knots speed to the equally useful, but less pretentious, tramp steamer, and one cannot but express gratification that the efforts of past years to bring the Cunard Line under foreign influence were resisted successfully by the determination of the directorate to ensure that the line would continue exclusively British. The policy then adopted has been maintained ever since under the chairmanship of Sir A. A. Booth, Bart., and at the same time there has been increased enterprise and activity in shipbuilding, associated with the firm determination to ensure the reliability, from every standpoint, of the ships and their machinery. The success in this respect is the more remarkable, as the company are amongst the foremost in the world in point of the introduction of innovations, alike in the propelling machinery and in the general arrangement and planning of ships, a policy which is directly due to the influence of the chairman. When the full story of the participation of the merchant fleet in war operations can be told it will be seen how large a part the Cunard Company have played, while the absence of breakdowns of their ships during service is a state of affairs which redounds to the credit not only of those responsible for the design and construction of the vessels, but almost still more of those who have the responsibility for keeping them in a state of working efficiency. This is not the time to speak of the great utility in war service of what are termed "intermediate" ships, especially for the transport of troops, as in these vessels, where no first-class passengers are carried, the second-class quarters are noted for their simple comfort rather than luxury, while special attention is given to the quarters of the third-class passengers, in which the troops find a condition of affairs which is most satisfying.

Under these circumstances we have great satisfaction in publishing drawings of one of the latest ships, just put on the North Atlantic service, which belongs to this particular type. The arrangement of the ship is due to the naval architect of the company, Mr. L. Peskett, than whom few have had greater experience in meeting the requirements of all classes of ocean travellers. The vessel, which was built by Messrs. Swan, Hunter and Wigham Richardson, of Wallsend-on-Tyne, represents a type which will be of great service, as, in addition to extensive passenger accommodation, she has large cargo holds. Of a length of 538 ft. 6 in., a beam of 65 ft. 4 in., and a depth of 46 ft. 6 in., and constructed to the Convention regulations, the Aurania carries, including the crew, 2,335 persons, and has a capacity for cargo of 400,000 cub. ft., of which 50,600 cub. ft. is insulated. Her gross tonnage is 13,936 tons, and with geared turbine machinery of approximately 7,200 shaft horse-power she will have a sea speed of 14 knots when displacing 21,405 tons. When it is calculated that her probable coal consumption will be only about 4 tons per hour, it will be realised that the propelling expense is very favourable in view of the large earning power indicated by the passenger and cargo capacity.

We publish this week, on Plate LXX, Figs. 1 to 12, a longitudinal section and a plan of each of the decks, while on page 610 there is given a detailed cross-section showing all the scantlings. In view of the latter illustration it is not necessary to enter into any details regarding the structure, as the particulars are fully given on the section. It will be noted from the longitudinal section, Fig. 1, that there are 11 main transverse bulkheads and six decks, in addition to the promenade and boat decks, the arrangements for the support of these decks, &c., being clearly shown on the cross-section. The watertight bulkheads are carried up to the underside of the shelter deck, and all scuppers and discharges from the upper deck are fitted with screw-down valves. All discharges from decks below the upper deck are conveyed to special wells on the tank top, and all are fitted with separate pump suctions.

Of cabin passengers, 506 will be carried. These, normally, are all graded second class, and as the position for the rooms for them is exactly that given in the faster liners to first-class passengers, it will be recognised that great advantage accrues from travelling by the intermediate ships. Thus the public rooms, the writing-room, the lounge and smoking room, and the gymnasium, are placed on the promenade deck, as shown on the plan, Fig. 5, over the forward end of which there is located the navigating bridge, Fig. 2. These have all great height with coach roofs, piercing the boat deck, as shown on the plan, Fig. 4. Forward on this boat deck, and immediately under the bridge, are the officers' rooms, &c., with private companion-way to the navigating bridge above. The public rooms for the saloon passengers have all communication by corridor with each other, as well as stairways to the decks below, while on the deck itself there is a promenade space with sheltered corners, which are much appreciated by passengers when the vessel is at sea. The bridge deck, as shown in Fig. 6, has state-rooms for 160 cabin passengers and a number of the rooms are fitted with cots for children. The deck is flush with the forecastle and poop, above the latter of which is a docking bridge, as shown in Fig. 3.

The shelter deck is shown in Fig. 7, and here are rooms for 346 cabin passengers and 44 children, all amidships. This shelter deck extends right fore and aft, marking the upper part of the moulded structure of the ship. Immediately below it is the upper deck, Fig. 8, on which is provided the cabin-passenger and third-class dining saloons, with the galleys and complete cuisine department between the two. The former dining saloon has sitting accommodation for 232 and the third-class room for 420 persons. Forward, on this deck, accommodation is provided for the third-class passengers' general room and for firemen and others of the crew, while aft there is a third-class smoking-room and general room, hospital, and other offices. The main and lower decks, Figs. 9 and 10, are given up forward and aft to the third-class passengers, while the engineering staff is accommodated, as usual, close to the turbine-room hatchway. The orlop deck plan, Fig. 11, shows the arrangement of the holds, machinery space, the coal bunkers and reserve bunkers. By the provision of extensive reserves forward of the boiler rooms, a very large supply of fuel can be carried. As regards the accommodation, generally it may be said that all cabin state-room wash basins are supplied with a continuous flow of fresh water, and in the public lavatories there is a service of hot and cold water. Great attention has been paid, also, to the heating and ventilation of all quarters, the cabin accommodation being heated by a low-pressure steam system, with radiators in the rooms and corridors, and the third-class by means of the Rigothermo system. Cold air is delivered inside the rooms on the shelter deck, and there are exhausting arrangements in the alley-ways on the bridge deck and also in the public rooms and dining saloon. Fireproof bulkheads are arranged in the cabin accommodation, with fireproof doors, while the Rich fire indicator is fitted in the bridge, with the usual connecting pipes to all cargo holds and 'tween decks. Lighting throughout is by electricity, the turbo-generators having a collective capacity of 300 kw., and, in this connection, it may be said that an emergency dynamo is fitted on the shelter deck far above the load-line, as shown in Fig. 7, for the working of the wireless telegraph and emergency lighting in the case of accident. Ship provision stores are fitted on the main deck, with the usual number of insulated rooms with brine cooling arrangements.

As regards the deck and navigating machinery there are nine cargo winches, with fourteen steel derricks on masts and derrick posts, two warping winches and four boat winches and windlasses, in addition to the usual capstans, as shown in Fig. 6. The Hastie steering gear is fitted with a telemotor control. There are the usual telegraphs, stoking indicators and tell-tales, while the Stone-Lloyd system is applied in connection with watertight doors below the upper deck. The arrangement of boats is shown in Figs. 4 and 6. There are 12 open lifeboats and 24 deck-boats, and all the boat davits are fitted with turn-out gear.

The propelling machinery adopted in the vessel is of the geared-turbine type, and has been manufactured by the Wallsend Slipway and Engineering Company, Limited, who, under the general managership of Mr. Andrew Laing, have done so much for the Cunard Company, and in many cases have led the way in developments towards economy and speed. In this case, as in many other instances, the work of design and construction has been supervised by Mr. A. Galbraith, who has been responsible for many years for the maintenance and working efficiency of the machinery of all Cunard liners. He has thereby gained great experience, and much of the reliability in the working of new vessels is due to his guidance in all questions of design. Here, as in many other instances, every effort has been made to ensure regularity in running, as well as comfort for the engineering crew. A success worthy of special note is the admirable ventilation of the machinery compartment, particularly the turbine-room.

The propelling engines consist of two sets of turbines, each set driving a propeller shaft through mechanical gearing, the vessel being of the twin-screw type. The power developed by the turbines in the aggregate corresponds to about 7,200 shaft horse-power in ordinary service at sea, the revolutions of the propeller under these conditions being about 100 per minute. The machinery has been constructed under the survey of the Board of Trade for a passenger certificate; it also complies with the rules and regulations for Lloyd's classification, and, in addition, will pass the American survey. Views of the twin sets of turbines in the Wallsend works are given on Plates LXIX. and LXXI.

We may begin our detailed description of the various units in the boiler-rooms and engine-room by reference, first of all, to the boilers, of which there are four, as shown on the plans, Figs. 11 and 12, on Plate LXX, arranged in two boiler-rooms, with bunkers between them. The boilers are of the multitubular, double-ended return-tube type, of 17 ft. 6 in. mean diameter and 20 ft. 9 in. long over the end-plates. Each boiler is fitted with eight furnaces of the Morison suspension type, and with back ends suitable for easy withdrawal. A separate combustion chamber is provided for each furnace. The boilers have been constructed throughout so as to permit of a working pressure of 190 lb. per square inch being maintained. Superheating arrangements are fitted to all boilers, the special fittings for these, consisting of tube elements and headers, having been supplied by the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne. The degree of superheat will normally be 125 deg. F. All steam stop valves through which superheated steam passes have cast-steel chests with steel fittings. Diamond

GEARED TURBINE TWIN-SCREW CUNARD LINER "AURANIA."

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LIMITED, SHIPBUILDERS, WALLSEND-ON-TYNE.

MIDSHIP SECTION.

Moulded dimensions: 520' × 65' × 46' 6" to shelter deck.

To Class 100 A 1 *Lloyd's. Shelter Deck.*

Numerals.

Breadth ...	...	65.0
Depth ...	...	38.5
		103.5 = 1st No.
Length ...	...	520
		53,820 = 2nd No.

Proportions.

$\frac{L}{D}$	to upper deck ...	$\frac{520}{38}$	= 13.68
$\frac{L}{D}$	to shelter ,, ...	$\frac{520}{46.5}$	= 11.8
$\frac{L}{D}$	to bridge ,, ...	$\frac{520}{54.5}$	= 9.55
d to F	,, ...		= 17' 10"
d to G	,, ...		= 9' 10"

Equipment.

3 bower anchors, stockless, each 109 cwt.

330 fathoms of 2¼" stud chain cable.

120 ,, 6" stream wire.

130 ,, 7" steel wire tow rope.

4 warps and hawsers, 120 fathoms, each 8".

Riveting.

Butts of shelter deck, sheerstrake double straps, treble-riveted from within bridge to ½ L from midship section to treble-riveted overlaps at ends where 0.68 and under; quadruple in way of bridge.

Butts of strake below shelter deck, sheerstrake double straps treble-riveted from within bridge to ½ L from midship section to treble overlaps at ends where 0.68 and under; quadruple in way of bridge.

Butts of bridge deck stringer treble-riveted overlaps.

Butts of shelter deck stringer in bridge, treble-riveted overlap butts; outside bridge, quadruple-riveted overlaps for ½ L from midship section to treble at ends.

Butts of upper "E" and "F" deck stringers, treble-riveted overlaps.

Butts of outside plating from keel to upper turn of bilge, quadruple, and to treble at ends where 0.68 and under.

Butts of outside plating from upper turn of bilge to strake below sheerstrake, quadruple from midship section to treble at ends.

Butts of centre keelson quadruple-riveted for ½ L from midship section to treble at ends.

Butts of flat keel plate and doubling single straps treble-riveted to quadruple overlaps at ends.

Butts of margin plate treble-riveted overlaps.

Butts of middle line strake of inner bottom treble-riveted for ½ L from midship section to double at ends where 0.48 and under.

Butts of inner bottom double-riveted overlaps.

Butts of bridge deck plating double-riveted overlaps.

Butts of shelter deck plating treble-riveted from within bridge to ½ L from midship section to single at ends where 0.42 and under, double-riveted in way of bridge.

Butts of upper and second deck plating double overlaps for ½ L from midship section to single at ends.

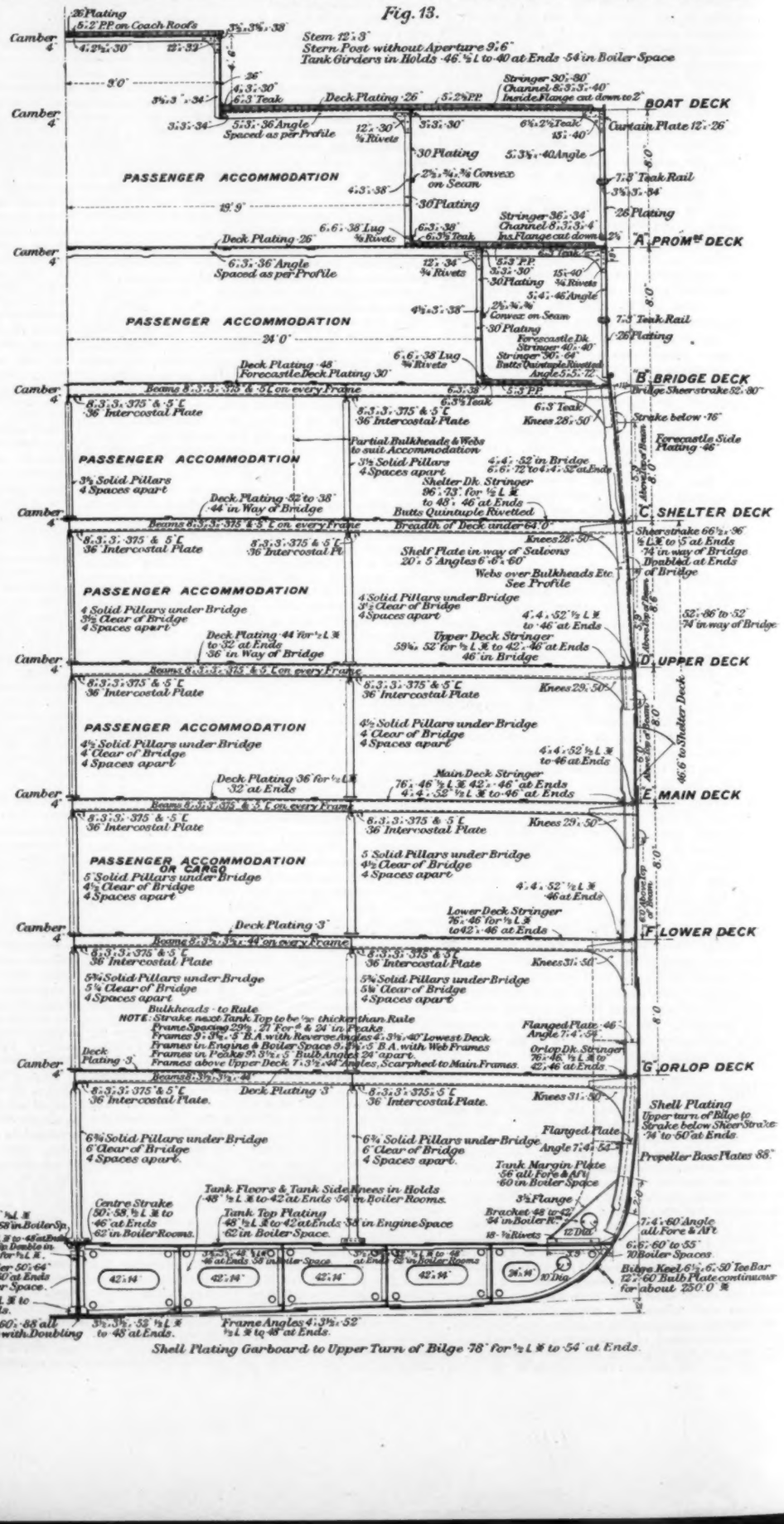
Edges of outside plating from keel to upper turn of bridge double-riveted.

Edges of outside plating from upper turn of bilge to strake below, sheerstrake double-riveted; edges to be treble-riveted for ½ L of vessel in the fore and after bodies for a depth of one-third the depth of the vessel (sketch to be submitted).

All deck seams single-riveted.

Edges of inner bottom plating single-riveted overlaps. Edges of middle line strake double-riveted all fore and aft.

Fig. 13.


Stem 12"x3"
Stern Post without Aperture 9"x6"
Tank Girders in Holds 46.½ L to 40 at Ends 54 in Boiler Space
BOAT DECK
PASSENGER ACCOMMODATION
A PROM.E DECK
B BRIDGE DECK
C SHELTER DECK
D UPPER DECK
E MAIN DECK
F LOWER DECK
G ORLOP DECK
Deck Plating 26
Deck Plating 48
Forecastle Deck Plating 30
Deck Plating 52 to 38
Deck Plating 44 for ½ L ℳ to 32 at Ends
Deck Plating 36 for ½ L ℳ 32 at Ends
Deck Plating 3
Shell Plating Upper turn of Bilge to Strake below Sheerstrake 74 to 50 at Ends
Propeller Boss Plates 88"
Frame Angles 4"x3½"x52 ½ L ℳ to 48 at Ends.
Shell Plating Garboard to Upper Turn of Bilge 78" for ½ L ℳ to 54" at Ends.

blowers have been arranged in connection with each combustion chamber, with all fittings complete. The Brundrit patent temperature balance has been fitted to each boiler for promoting automatic circulation of the water. The whole of the boiler installation has been designed for working under natural draught conditions, and the furnace fittings have been arranged in accordance with the Cunard Company's special requirements, embodying such details as firebars of the "Trident" pattern and patent backbridges as supplied by Messrs. Railton, Campbell and Crawford, Limited. Two funnels are provided, of elliptical section, and having an outer casing about 18 in. clear of the main chimney. The height of the chimneys is about 130 ft. above the base line. The uptakes and chimneys are fitted with division plates for each boiler, these being carried the full height of the chimneys so as to make the draught for each boiler independent. Sectional dampers are also provided in the uptakes for isolation purposes. At the forward side of the forward funnel is fitted a set of triple bell whistles in connection with a set of Willet-Bruce control gear, the whistles and gear having been supplied by Messrs. T. Downie and Company, of Liverpool.

As previously mentioned, the vessel is arranged for twin-screw propulsion, the port and starboard lines of shafting being each driven by an independent set of geared turbine machinery. Each set consists of a high and low-pressure turbine working in series and coupled to the pinion shafts by flexible couplings, the pinions being situated one on each side of the gear wheel, which in turn is coupled direct to the propeller shafting. The astern-going turbines are incorporated in the exhaust end of the low-pressure turbine casings.

The turbines are of the Parsons design, and of the impulse-reaction type, an impulse wheel being introduced, as the initial stage in the high-pressure ahead and the high-pressure astern turbines, to take the first drop in pressure. The impulse wheels are followed in each case by the usual reaction stages, while the low-pressure turbines consist entirely of stages of reaction blading.

The rotating portions of the turbines, comprising the bodies of the rotors and the spindle ends, are made entirely from ingot steel forgings. The turbine casings, which in an ordinary way would have been entirely of cast-iron, have in this case been constructed partially of cast steel, in order to withstand the superheated steam with which it is intended to work these turbines. Those portions of the turbines which are made of cast steel are the steam admission ends of both the high-pressure ahead and high-pressure astern turbines. Similarly the material of the blading is partly of copper and partly of the usual brass mixture, the copper sections being fitted to the impulse wheels and to the earlier stages of reaction blading.

The gearing is of the double helical type, arranged with a spiral angle and depth of tooth, which experience has shown to be most suitable. The main gear wheel is constructed with a cast-steel central portion, to which a heavy steel forged rim is attached. The pinions are of nickel steel. Central bearings are provided for the pinion shafts to ensure the necessary alignment being preserved. For the efficient and silent running of this gearing it is essential that the lubrication arrangements should be as perfect as possible, and as a means to this end sprayer nozzles, distributed at suitable intervals, are arranged to spray the oil direct on to the engaging teeth, thereby providing a film of oil between the surfaces in contact. The shaft bearings for the turbines and the gearing are also arranged to work under a system of forced lubrication.

The thrust shafts, main line shafting and propeller shafts are of forged ingot steel, the strength of the shafting being considerably in excess of Board of Trade and Lloyd's requirements. The propellers are of the built-up type, with four manganese bronze blades to each, which are secured to the propeller bosses by Lowmoor iron studs and gun-metal cap nuts. The bosses are made of cast steel.

The floor-level at the starting platform is at about the centre line of the turbines, and the whole of the manœuvring valves are supported on a pedestal suitably placed so that the control wheels on the valve spindles are at a convenient height for operating; the pressure gauges are also grouped in close proximity, the whole forming a compact and easily controlled arrangement. Pipe connections are taken from the valves to the steam strainers, which are directly attached to the turbines.

The condensers are of the Weir "Uniflux" type, and are placed at a level such that the low-pressure turbines drain into them; in this way the accumulation of moisture at the low-pressure end of the turbines is reduced to a minimum. The above arrangement also obviates the use of the somewhat objectionable overhead connecting trunk between the low-pressure exhaust and condenser.

Air pumps of the "dual" type, as supplied by Messrs. G. and J. Weir, Limited, are fitted to work in conjunction with the condensers. The condensing plant is made capable of maintaining a vacuum of 28½ in. when the machinery is working under the sea-service conditions, with the barometer at 30 in. and sea water at 60 deg. F. Two centrifugal circulating pumps are fitted for supplying the circulating water to the main condensers. These pumps are each fitted with one single-cylinder, double-acting, enclosed, forced-lubrication engine, and have been supplied by Messrs. M. Paul and Company, Limited, Dumbarton.

The boiler-feed pumps consist of two pairs of direct-acting vertical pumps, each pair being capable of delivering the necessary feed water under ordinary service conditions. The feed pumps deliver the feed water through one large surface feed-water heater of the multiflow type, which is designed to utilise the exhaust steam from the various auxiliaries. The feed pumps and feed heater are all of Messrs. Weir's make. The whole of the foregoing pumps have United States metallic packing fitted to the piston rods. A feed-water filter of the "Cascade" type, as supplied by the Contraflo Condenser and Kinetic Air Pump Company, Limited, is fitted, the filter tank being provided with the necessary float gear for controlling the feed pumps. The air pumps are arranged to deliver the feed water to this filter tank and the feed pumps to draw therefrom.

An auxiliary condenser of Weir's uniflux design is fitted, and is capable of dealing with the exhaust steam from the whole of the auxiliary and deck machinery. This condenser is of the non-vacuum type, no air pump being required under these conditions. Circulating water for this condenser is provided by a centrifugal pump driven by a single-cylinder, enclosed, forced-lubrication engine supplied by Messrs. Paul. The condenser drains to a special tank having automatic gear, which controls a vertical duplex feed pump, both tank and pump having been supplied by Messrs. Thom, Lamont and Co. This pump delivers the feed water from the tank to the boilers through a discharge filter supplied by Messrs. Railton, Campbell and Crawford, of Liverpool. Alternative suction connections from other pumps are also fitted to this tank.

In connection with the forced lubrication system there are fitted three single-cylinder direct-acting vertical pumps, which have been supplied by Messrs. Weir. These pumps are arranged with suctions to the oil drain tanks situated in the double bottom of the vessel and arranged to deliver through an oil cooler of multi-tubular design. The connections are such that delivery can be made either to gravitation tanks or direct to the gearing and turbine shaft bearings, the oil after use finally draining back to the tanks in the double bottom. For supplying circulating water to the oil cooler a duplex pump of the vertical type, as made by Messrs. Thom, Lamont and Co., is provided and fitted with all the necessary connections.

Other auxiliary machinery fitted by the machinery contractors in the vessel comprises the following:—Two sanitary, bilge and fire pumps, of the vertical duplex type, with suctions from the sea and bilges and arranged to deliver overboard, and on deck for sanitary, wash deck, and fire service purposes; a bilge and a sanitary pump worked from the end of the gear-wheel shaft, through a crank-pin and connecting rod, with similar connections to those named for the duplex pumps; an additional bilge pump of the vertical duplex type in the forward boiler-room with connections to draw from the bilges and deliver overboard; a ballast pump of the vertical duplex type, capable of discharging 200 tons of water per hour, to draw from any forward, and deliver into any after, tank, and with connections for performing various other duties; two pumps of the vertical duplex type, with suction and delivery connections as necessary, for dealing with the fresh water for washing and drinking water purposes. The whole of the above-named duplex pumps have been supplied by Messrs. Thom, Lamont and Co.

The evaporating and distilling plant includes the following:—Two evaporators, each capable of producing 50 tons of water per 24 hours, and delivering their vapour by alternative connections to the condensers, low-pressure turbines, or feed-heater, and distiller. The distiller is capable of condensing 50 tons of washing and drinking water per 24 hours at 65 deg. F., with circulating water at 60 deg. F. The evaporators and distiller have been supplied by Messrs. Caird and Rayner, of London. For providing the feed water for the evaporator a pump of the vertical single-cylinder type is fitted, this pump having been supplied by Messrs. Weir. A feed filter, supplied by Messrs. Railton, Campbell and Crawford, of Liverpool, is fitted in the delivery pipe-line of fresh water from the distiller. Circulating water for the distiller is supplied by a vertical duplex pump of Messrs. Thom, Lamont and Co.'s make.

The auxiliary machinery generally is made suitable for a working pressure of 190 lb. per square inch; the air pumps and feed pumps are also suitable for working with a superheat of 50 deg. F. The duplex pumps are capable of performing their respective duties with a working pressure of 150 lb. per square inch, and all pumps are large enough for their work when exhausting against a back pressure of 20 lb. per square inch. The water ends of the pumps in most cases are made of gun-metal.

The question of radiation of heat from external hot surfaces, extending from that of the boilers to exhaust and feed pipes, more particularly now that superheated steam is employed, has received careful attention, and all parts from which heat can escape have been covered with some form of non-conducting material.

A workshop has been fitted out in the engine-room on the bottom platform at the starboard side of the thrust shaft, and store-room on the port side. In the workshop there has been installed a 6¼-in. centre double-geared lathe having an 8-ft. gap bed; it is of an improved self-acting, sliding, surfacing and screw-cutting type. There is also a 30-in. double-geared pillar drilling machine, having a 2½-in. spindle with 10-in. feed, either hand or automatic. In addition there is one 30-in. by 4 in. grindstone, provided with fast and loose pulley. These machine tools are driven by a 3-h.p. totally-enclosed electric motor suitable for 112 volts, direct-current and shunt-wound. For transmitting the power from the motor to the machines the necessary countershafts and pulleys are fitted. The whole of the above machines, together with the motor, have been supplied by Messrs. C. Booth and Co., Liverpool.

For dealing with the ashes and other refuse that accumulates in the boiler-rooms, there is provided in each of these compartments an 8-in. silent ash hoist, as made by Messrs. Railton, Campbell and Crawford, of Liverpool. Special shafts are constructed independent of the ventilators for the above hoists. In addition the stokehold ventilators are fitted with small geared wheels and shafting for turning them.

The ventilation of the engine and boiler rooms has been carried out in a very complete and effective manner, and for both compartments the ventilating trunks below the casing top are built as part of the vessel's structure. For the engine-room there are two trunks, each having a 48-in. diameter tube and cowl above the engine-room casing, the cowl being turned by gearing from below. At the lower end of each trunk is fitted a 45-in. Keith open-type centrifugal fan, provided with deflector. The fan is driven by a vertical shaft enclosed electric motor of Messrs. Laurence Scott and Co.'s make. Each of the above fans, when running at a speed of 600 r.p.m., is capable of dealing with 30,000 cub. ft. of air per minute. Each one of the four stokeholds is provided with two ventilating trunks, which are surmounted with 48-in. diameter tubes and cowls, turned by gearing from a lower deck level. The space between the inner and outer chimneys is arranged as the means of egress for hot air from the boiler tops.

THE EFFECT OF SODIUM HYDROXIDE ON BOILER PLATES.—In certain districts where feed water for boilers contains sodium hydroxide many boiler troubles have appeared which have given no little concern to boiler users and makers. Such water is found in the central eastern part of Illinois, in the Fox River Valley in the northern part of the same state, and in portions of other States. The Engineering Experiment Station of the University of Illinois has just completed an investigation of this source of boiler distress, and the results are published in Bulletin 94 by S. W. Parr. It was noted that boilers using feed water containing sodium hydroxide often developed fine cracks radiating from rivet holes or extending from hole to hole. The experiments showed that the effect upon the metal is to cause brittleness, which makes it less capable of withstanding steam pressure and temperature changes. Among the remedies suggested is the addition of a salt having properties which cause it to react with the alkali and yield a harmless product. Copies of Bulletin No. 94 may be obtained gratis by addressing C. R. Richards, Director, Urbana, Illinois, U.S.A.

NITROSTARCH AS AN EXPLOSIVE.—The name dynamite was first chosen by Nobel to designate the relatively safe explosive which he obtained by impregnating kieselguhr with nitroglycerin. The name has since become general for certain explosives, which may or may not contain nitroglycerin. Gelatine dynamites are solutions of guncotton (nitro-cellulose) in nitroglycerin; guncotton itself is scarcely suitable for mine blasting; attempts have been made to find a substitute for gelatine dynamites, and success has recently been obtained with starch, which chemically bears a strong resemblance to cellulose. According to S. S. Sadtler (*Metallurgical and Chemical Engineering*, April, 1917) starch forms nitro compounds —more correctly nitrate esters—like cellulose, and they are less bulky and less expensive than guncotton, and make a superior blasting agent. The nitrostarch is stable, has been stored for 10 months, does not freeze, and can only be exploded by the aid of a detonator. At the present time both starch and cellulose are scarce; in normal times starch is very much the cheaper material, and if the nitration of starch should really prove to be as simple as claimed, more will be heard of nitrostarch.

BALL COUPLINGS AND UNIVERSAL JOINTS.

WE illustrate on this page, Figs. 1 to 5, an ingenious type of universal joint due to M. R. Guillery, and described by him at the meeting of the Paris *Académie des Sciences* held on November 13, 1916. The idea embodied in this coupling will be best understood by reference to Figs. 2 and 3. One of the shafts to be coupled is provided with four arms, which enter into slots formed in a cup-shaped flange keyed to the other shaft. The two interlocking parts thus form a kind of claw coupling, but balls are interposed as shown between the adjacent surfaces of the two main components of the coupling. These balls rest on spherical seats, as indicated. The elasticity necessary to enable the coupling to operate as a flexible coupling is provided as indicated in the figures by slotting the ends of the claws as shown in Figs. 2 and 3. An alternative method is indicated in Figs. 4 and 5, which represent the plan adopted in applying the system to the construction of flexible shafting. In this case the components are fitted as indicated inside a length of the now well-known flexible metallic tubing. It is claimed that such shafts can transmit a considerable torque.

A geometrical discussion of the coupling was given by M. Guillery in his paper, which showed that but a small amount of elasticity was required to permit of the coupling being used to connect shafts making a considerable angle with each other. If, for instance, the left-hand length of shafting in Fig. 2 is given an angular displacement in the plane of the paper, the balls will roll a little on their seats. Their centres will then be a little closer together than when the two lengths of shafting are co-axial, but the amount is small. To calculate the value of this displacement M. Guillery assumes that the ball (Fig. 1), with centre O, is placed between the two spherical cups I and II of radius R; the centre C of cup I is fixed, the centre D of II can turn about a point P—not marked—which will under normal conditions coincide with C and will under other conditions slide along the line C O D. When the ball turns without sliding, the cup I will rotate about C, whilst centre D will be displaced to D^1, and this rotation will push C a little further out, to C^1. If α be the angle between O C and the normal to the new point of contact between the ball and cup II, the displacement $C C^1$, which is the extension of the line D O P, will be $x = (R - r) \cdot [\sqrt{4 - \sin^2 \alpha} - (1 + \cos \alpha)]$, and if R = 25 mm., r = 10 mm., $B B^1 = 2$ mm., α will be 11½ deg. and $x = 0.15$ mm.

INDUSTRIAL NOTES.

A CONFERENCE on the selection and training of welfare supervisors in factories and workshops was held on Saturday, the 23rd inst., at the Home Office, between representatives of that department, the Ministry of Munitions, and the Board of Education, and of various universities and other educational institutions. The conference discussed the nature and length of the course of training required for welfare supervisors—particularly those seeking employment in the larger factories, the extent and character of the special instruction to be provided for in addition to, or as part of, a general course of social study, the arrangements to be made for giving the candidates a practical training in welfare work both inside and outside the factory, the means of ascertaining the fitness of candidates and of eliminating those who are unsuited, the standard to be required for any certificate or diploma, and the methods in which uniformity of standard might be achieved. The need and practicability of making special provision for the training of welfare supervisors appointed from the ranks of the workers themselves who may not be in a position to take the full course of training were also reviewed. Attention was drawn to the importance of the universities securing the co-operation and interest of employers' and workers' associations in regard to welfare training, whether by means of advisory boards or otherwise.

The development of the mineral resources of Great Britain and Ireland, now being undertaken by a department of the Ministry of Munitions under the direction of Sir Lionel Phillips, is likely to lead to far-reaching results; considerable work has already been done in furthering war purposes. Steps are being taken to control and expand wolfram mines, from which it is expected to produce a home supply of tungsten powder.

A complete survey of the lead resources of the country is also being carried out; new sources of supply are being investigated and old workings reopened. In one instance steps have been taken to assist in the drainage and development of an important lead mine, from which there is a prospect of an immediately increased output. Action is also being taken with regard to the production of zinc. A sulphur pyrites mine has been acquired, and certain low-grade copper deposits of considerable extent and promise are being carefully watched with a view to giving assistance in their working.

In the course of its immediate operations the Department is gaining valuable information which will allow it to offer future suggestions as to the prospect of the normal base metal industry of the United Kingdom. It will also be enabled to report on the relative cost of home production against importation, and to advise as to the placing of the industry in the best position to meet emergencies.

The Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm Acts, the Defence of the Realm Regulations, the Munitions of War Acts, and all other powers, has ordered that all persons (other than railway companies) owning or having in their possession or under their control any steam-driven highway lorries or trailers in Great Britain shall, within 14 days from the date of the Order (June 25), send in to the Deputy Director-General of Railway Material Licences, Ministry of Munitions, Whitehall-place, London, S.W. 1, returns containing the particulars with regard to such steam lorries and trailers in the form set out in the tabular statement given with the Order, and to make such further return concerning any such steam lorries and trailers as may hereafter be required by the Deputy Director-General of Railway Material Licences.

The Board of Agriculture and Fisheries, the Ministry of Munitions, and the National Service Department, desire to call the attention of all employers of labour to the fact that it is contrary to the national interests for agricultural workers to forsake their usual occupation for munitions factories, works of construction, and the like. Such men can best serve the country at the present time by remaining on the land and assisting in the production of food.

Employers should satisfy themselves by every means in their power when engaging fresh labour that they are not supplying their own requirements at the expense of agriculture by taking in men who would ordinarily work on farms. Instructions to the above effect have been given to the Employment Exchanges.

The following is an abstract of the remarks made by Mr. W. A. Appleton, general secretary of the General Federation of Trade Unions, in the eighteenth annual report, 1917, issued by the federation: ". . . Neither altruism nor folly should altogether govern the policy of the peace-makers; it is permissible to ask those who cry out for peace without annexations or indemnities where they would place the burden of cost—upon the aggressor or upon his victims? If there are to be no indemnities, who is to compensate the workers of Belgium, France, Serbia, Roumania, Montenegro and Poland for the material losses they have sustained and for the mental agony they have endured? Who is to compensate the workers in neutral countries whose maritime trade has been destroyed and whose seafaring populations have been ruthlessly exposed to danger, suffering and death? . . ." In regard to industrial unrest the report says that "Grievances only partially removed have grown, while the methods of dealing with them have not improved, and the substitution of Government for trade union action, plus a policy of secrecy and oppression, has developed very serious discontent. It is, of course, notorious that some men live only to fan the flame of discontent. They have no scruples. They call themselves revolutionaries, and the best of them frankly and honestly aim at the creation of a social state which has ceased to know either inequalities or pain. Their mental outlook prevents them from seeing that disastrous results may follow beneficent intentions, if these intentions ignore economic laws and social rights . . . By its efforts to order all the outgoings and incomings of industrial workers the Government has created opportunities for every type of revolutionary, and with the aid of its press censorship, by the suppression in this country of facts and information that were notorious both in enemy and allied countries, has fanned the fires lighted by the irresponsibles and irreconcilables. It will not overcome the difficulties by the appointment of labour men to positions which require retrieving rather than developing. A far better way would be the restoration of individual liberties, the removal of Governmental controls and an exhibition of confidence in the people's goodwill and good judgment. . . ."

In 1916 the number of societies affiliated to the federation was 146, with an aggregate membership of 1,076,634; in 1917 the figures were respectively 141 and 873,415. The reserve fund in 1917 amounted to a total of 178,253*l.* 19*s.* 7*d.*, or an increase of 42,965*l.* 17*s.* 9*d.* over the total for the preceding year.

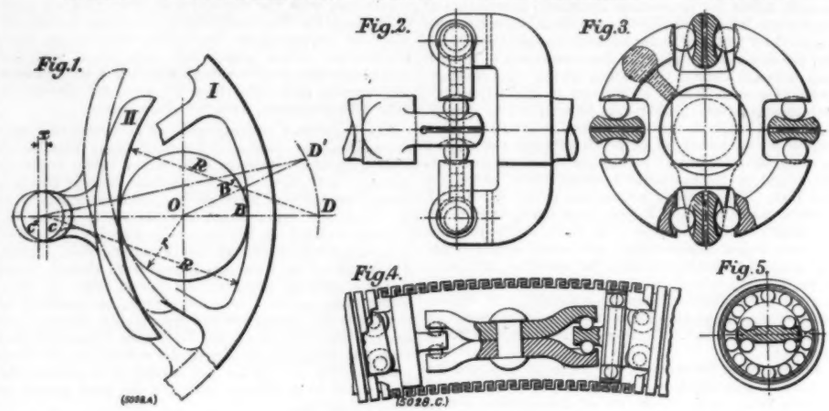
Grave doubts are expressed, says *The Textile Mercury*, as to the beneficial effect on boys of the large wages they are now earning in cotton mills. In fact the same dubiosity exists in regard to the excessive wages now being received by men and women engaged in munition factories. Those persons have been unaccustomed to such large earnings, which are therefore not unlikely to encourage extravagant notions. Those who have influence over these workers should instil into them the idea of making hay while the sun shines, coupled with the assurance that cloudy days will again come.

According to an Oldham statement, a boy of 13½ years went to three different mills within six months of leaving school, and increased his wages from 6*s.* to 32*s.* per week. Another boy, 13 years of age, was earning 30*s.* per week; and a third, described as probably exceptional, aged 16 years, was earning 47*s.* per week as a minder. Of course we are living in extraordinary times, but the wages paid in these instances are surely out of all proportion to the earning capacity of the youths. The *modus operandi* is for the youth to get a situation as little piecer, and after having learned the work to change to another mill as big piecer. If the introduction of a little piecer is hinted at he quickly intimates his intention to leave, and to prevent this the minder promises him a portion of the little piecer's wages. So the oracle is worked, and the wages are increased. When the time of adjustment comes, and wages have to come down to the normal level, then will come the tug of war.

In moving the adoption of the directors' report at the seventh annual meeting of Petters, Limited, Nautilus Works, Yeovil, on the 14th inst., the chairman, Mr. E. W. Petter, stated that the labour difficulties had not become less during the year. The policy of the directors would be, as it had always been, to pay good wages, and demand a fair return in work, while showing consideration to the employees. The company had now a pretty large pay roll; the amount disbursed during the past financial year in salaries and wages was in excess of 90,000*l.*

Representatives of the Scottish East Coast shipowners and of the National Union of Sailors and Firemen have agreed that the rate of wages of seamen

BALL COUPLINGS AND UNIVERSAL JOINTS.



be raised, as from the 9th inst., by 5s. per week, making the weekly wages 70s., or double the pre-war rate.

The Right Hon. G. N. Barnes, M.P., Pensions Minister and Member of the War Cabinet, in the course of a letter to *The Glasgow Herald* on the labour problems, asked what could be done to put industrial conditions on a better basis. First, he believed, the unions must give shop committees a recognised place in their union organisation. It was not enough to arrange the terms of agreement for workmen. Except in cases of urgency and emergency, they should be consulted before such terms became operative. This should be done through consultation with the shop committees, convened outside by the district committees of the trade. The shop committees should be made the medium through which to operate agreement, and for conveying the views of the shops through the shop stewards to the union district committees and executive authorities. The shop committees should be made the shop executive to uphold conditions agreed to by representative conferences of employers and employed. It might be said that this involved but little change. But, speaking from inside knowledge, he could say that it involved a good deal. The shop steward and shop committees had generally been kept at arm's length by the elected authorities of the union, a fact which accounted for a good deal of union troubles. They had had to fight for recognition from their own unions as well as from the employers, and in the fighting had been torn in twain. Whole-hearted recognition on the part of the unions would get rid of part at all events of industrial unrest.

But there should be recognition as well on the part of employers. Of course there was difficulty owing to conflict of interest of the different grades of labour. But there were at least some things in which there was identity of interest and in respect to which the employer and all grades might co-operate with advantage. There was the amicable settlement of purely workshop disputes, the framing and maintaining of rules for workshop discipline, and the provision of facilities for technical instruction. On all these things employers and employed might come together in a spirit of mutuality and goodwill, employers leaving each grade to manage its own business with its own union, but being willing, either direct or through representatives, always to meet any grade to deal with matters bearing upon payment of labour.

Let these things be done, let but a sustained appeal be made to the better nature of workmen, and he believed that shop stewards would cease to be mere irresponsible promoters of mischief and become partners and fellow-workers for industrial order.

A better atmosphere would be created, in which petty things would be viewed in proper perspective, and in which the best use would be made of the best means of production.

The Board of Trade announce that the duties hitherto performed by the Petrol Control Committee with regard to the distribution of petrol for civil and industrial needs will, in future, be performed by a petrol control department of the Board of Trade. The president has appointed Sir Evan Jones, Bart., M.Inst.C.E., to be controller of the new department, Mr. P. G. L. Webb to be deputy controller, and Mr. H. W. Cole to be chief clerk. Sir Evan Jones will retain his position as commissioner for dyes. The President of the Board of Trade has appointed Sir Walter Egerton, K.C.M.G., to be chairman of the Pool Board, which is responsible for co-ordinating the work of the various oil distributing companies.

THE PHYSICAL SOCIETY OF LONDON.

AT the meeting of the Physical Society of London, held on June 8, at the Imperial College of Science, Professor C. V. Boys, F.R.S., president, in the chair, a paper, entitled "*An Alternating Current Bridge Method of Comparing Two Fixed Inductances at Commercial Frequencies*," by T. Parnell, M.A., was read by Dr. Sumpner.

The paper describes a method of avoiding the troublesome double adjustment required in Maxwell's method of comparing inductances. A current detector, whose deflections depend on the component of the current in quadrature with the E.M.F., is employed, which makes it possible to arrange that the condition for no deflection depends chiefly either on the inductances or resistances. In series with the bridge is placed either a non-inductive resistance or a capacity. In the first case the balance depends chiefly on the inductances, and in the second case on the resistances. A few alternate repetitions of the two adjustments suffice to balance the bridge, both for resistances and inductances. As detector a sensitive moving coil galvanometer in conjunction with a commutator, or a Sumpner electrodynamometer, may be employed; the latter proved more satisfactory.

Discussion.—Dr. D. Owen said that this was simply the Maxwell bridge; but the author had shown how to use it under the best conditions. It was impossible to get satisfactory results without the double adjustment for inductance and resistance. Mr. Parnell had shown how this could be most easily done by using currents in quadrature with one another for the two adjustments. The difficulty still remained, however, that one adjustment upset the other; but it was satisfactory to note that the desired end was reached in a short time. The method was probably easy to apply with small inductances; but he would expect practical difficulties to arise with large ones. It was difficult to know what the phases of the bridge currents were with respect to the field current of the electrodynamometer, and there might be some trouble in getting on the right track. A similar method of using the electrodynamometer had been tried at the Bureau of Standards, a phase shifter being used to turn the phase of the voltage on the field coils through 90 deg. to get balances for the two conditions.

Mr. T. Smith pointed out that in double adjustments of this nature, if the wrong adjustment were made first, the successive errors got larger instead of smaller. It would have been helpful if the author had extended his mathematics somewhat, and given some criterion (*e.g.*, some function of the various quantities involved being either positive or negative) as to which of the adjustments —inductance or resistance—should be made first.

Dr. Bryan asked if the method could be used for small inductances of a few micro-henries.

Professor Boys asked if inductances with iron cores could be measured, or only air-cored coils, in which the sine law was nearly fulfilled.

Dr. Sumpner said, in reply, that the author had not gone in great detail into the range of usefulness of the method. He might point out, however, that the sine law was not essential to work with the electrodynamometer. The author did not appear to have experienced any difficulty about the order of the adjustments; though in some cases this might doubtless cause considerable trouble. He admitted the validity of the author's criticism of the paper by himself and Phillips; and agreed that the double adjustment was essential. At that time, however, he was principally concerned with describing the instrument, and was not using small inductances in which the resistance effect was important.

Mr. A. Campbell communicated the following: Mr. Parnell's system is interesting, and may be of value in other methods where two adjustments are necessary to obtain a balance. In connection with his commutator method it may be mentioned that L. T. Robinson applied a commutator in the galvanometer circuit in a somewhat similar way for testing transformers by inductance methods (Transactions, American Institute of Electrical Engineers, page 1040, vol. xxviii, June 30, 1909).

A paper, entitled "*On the Wave-lengths and Radiation of Loaded Antennæ*," was read by Mr. Balth. Van der Pol, junr.

The paper consists of a mathematical treatment of the subject, the following being some of the conclusions arrived at:—The radiation resistance of a loaded antenna, and also the radiation from the antenna, are dependent not only on the wave-length, but on the current values at the top and bottom. The radiation cannot, therefore, be written $\Sigma = \frac{A\,T^2\,l^2}{\lambda^2}$ where A is constant and T is the R.M.S. current at the base, as is done in most text-books. Rüdenberg's formula for flat-top or umbrella antennæ is valid only for very long wave-lengths, with a capacity at the top of the antenna very large compared with that of the vertical part, and Austin's table of radiation resistances up to ratios of $\frac{l}{\lambda} = 0.4$ is based on an unjustifiable extrapolation of Rüdenberg's results.

The paper also treats of the directions in which the energy is most strongly radiated under different conditions.

Discussion.—Professor J. A. Fleming communicated the following remarks:—The paper seems to me to be valuable and the analysis correct. The formula for the radiation resistance of a flat-topped antenna, which is commonly called Rüdenberg's formula, has no claim to be attributed to him; it can be at once derived from Hertz's expressions for the forces due to a small oscillator. As I have shown in my book on the "Principles of Electric Wave Telegraphy," third edition, Hertz's reduced expressions are obtained on the conditions that the current has the same value at all points in the rod of the dumb-bell oscillator; and hence applies also to the reduced formula for radiation resistance. The polar radiation curves, which the author has delineated for the higher harmonics of the loaded antenna, seem consistent with the delineation of the field of electric force round a rod oscillator given by F. Hack from the equations of Abraham (see Plate VI, Chapter V, "Principles of Electric Wave Telegraphy"). The possibility of projecting upwards in an inclined direction what is virtually a beam of electric radiation is interesting. By observing where the beam comes to earth it may be possible to determine the height of the reflecting masses of ionised air. There is, however, a certain difficulty in exciting any required harmonic in an antenna, especially if the capacity and inductance are chiefly located at certain points. When the possibility of experimental work returns it will be interesting to attempt to confirm these results experimentally.

A demonstraction of a method of preventing sparking at a rapid make and break, which incidentally produces colloidal platinum, was given by Dr. A. Griffiths. The apparatus exhibited was one described by him in the *Philosophical Magazine* for March, 1895, page 232. The device consists of a series of electrolytic cells placed as a shunt across the spark-gap. The electrodes consist of platinum and the electrolyte of strong sulphuric acid. The cells polarise, and on making the gap an E.M.F. is introduced opposed to the E.M.F. of the battery, so that the current rapidly diminishes, decomposing the liquid and doing chemical work.

Dr. Griffiths made the following statements:—

1. The platinum cathodes disintegrate and a colloidal solution of platinum is formed.

2. The cathode on the negative side of the spark-gap generally disintegrates to the greatest extent; the next cathode disintegrates less, and so on, the least disintegration occurring in the cell at the positive side of the spark-gap.

3. The cathodes develop, to the naked eye, an appearance as if they were covered with platinum black. Certain plates examined under the microscope seemed covered with numerous craters.

4. The production of gas does not appear to be the same in each of the electrolytic cells in series; sometimes no gas at all appears to be evolved from the most negative cathode.

5. The rate of disintegration of a cathode appears to be small when the cathode is first placed in the sulphuric acid, and appears to increase to a maximum in course of time.

6. One specimen of platinum appears to behave differently from another.

Dr. Griffiths added that by using electrodes made of gold leaf floated on glass with the aid of methylated spirits, he had obtained what was probably colloidal gold. Professor Hicks, of Sheffield, had told him that he had used electrolytic cells to stop sparking at a pendulum-mercury intermittent contact. He had not observed disintegration of the platinum as far as he (Dr. Griffiths) was aware.

Discussion.—Dr. R. S. Willows said he was interested in the chemical aspect of the experiment. There was no doubt that Dr. Griffiths was the first to obtain colloidal platinum, though he did not call it by that name when the result was originally described. The difference in the intensity of the action in different parts of the circuit reminded him of the similar phenomenon which occurs in a train of X-ray valves, in which most of the action takes place in one valve of the train. Measurements of the potential across each cell would be instructive.

Professor Boys mentioned that he had used electrolytic cells to quench the sparking of a pendulum contact in his gravitation experiments. He had not noticed any action on the platinum. To what did Dr. Griffiths attribute the effect?

Mr. A. Campbell communicated the following remarks:—Many years ago Helmholtz introduced the use of a condenser, shunted by a suitable resistance, across the spark-gap for the purpose of suppressing the spark. More recently a better system was employed by the engineers of the General Post Office, who kindly communicated it to the National Physical Laboratory, where it has been used with the greatest success on all kinds of spark-gaps (from 1 break per second up to 1,000 per second). This consisted in putting the resistance in series with the condenser. By adjusting the value of the resistance to suit the particular circuit it is nearly always possible to suppress the spark. There is no leak across the break, as in the shunt system.

Dr. Griffiths, in reply to Professor Boys, said that he thought the disintegration was due to the inductive rush of the current, but many points required investigation.

SHEFFIELD UNIVERSITY.—We are informed that the Privy Council has sanctioned the creation of new Faculties of Engineering and Metallurgy in the University of Sheffield. The Faculty of Engineering has elected Dr. W. Ripper for its dean, and Dr. J. O. Arnold has been appointed Dean of the Faculty of Metallurgy. The elections have been approved by the Senate.

THE LATE MR. RICHARD WHATELY.—We regret to have to announce the death in India, on the 17th inst., of Mr. Richard Whately, chief engineer of the Bombay, Baroda and Central India Railway Company. Mr. Whately was born on April 22, 1851, and was the son of the late Reverend Canon William I. Whately. He received his scientific education at Haileybury College, from 1875 to 1879, and then served a pupilage of four years under Mr. R. A. Marillier, resident engineer of the Hull Dock Company, with whom he remained for two years more, down to 1885, in training as an assistant engineer. From 1885 to 1888 Mr. Whately acted as assistant engineer on the Victoria Dock construction, Bombay, a work for which Messrs. King and Co. were the contractors. He then joined the Bombay, Baroda and Central India Railway as assistant engineer, and was in charge of the survey and construction of the Anand-Petlad Railway. Later, from 1890 to 1893, Mr. Whately was occupied in the survey of a part of the Godhra-Rutlam Railway, and was in charge of the first 25 miles of the construction. Subsequently, and down to the year 1894, he acted as resident engineer on the Bombay, Baroda and Central India Railway, and was in charge of the construction of the Rutlam division of the Godhra-Rutlam Railway, 56 miles. He then acted for one year, down to 1895, as resident engineer on the Bombay division, when he was transferred to the construction of the Rajpipla State Railway, and was in charge, down to 1899, of 80 miles of the doubling of the main line, Bombay, Baroda and Central India Railway; on completion of this latter work he was transferred as resident engineer of the Bombay division. He was then resident engineer of the Broach division from 1899 to 1901, and again resident engineer of the Bombay division from 1901 to 1903. From 1903 to 1905 he was executive engineer of the Phulera division, 77 miles, of the Phulera–Rewari construction, and on the completion of this work he was transferred to the Delhi division, 475 miles of open line. He was shortly afterwards appointed executive engineer of the Bombay, Baroda and Central India Railway, of which he was the chief engineer at the time of his death. Mr. Whately was a member of the Institution of Civil Engineers from January, 1908.

TURRET FOR TURNING THE COPPER BANDS ON SHELLS.

CONSTRUCTED BY MESSRS. MAVOR AND COULSON, LIMITED, ENGINEERS, GLASGOW.

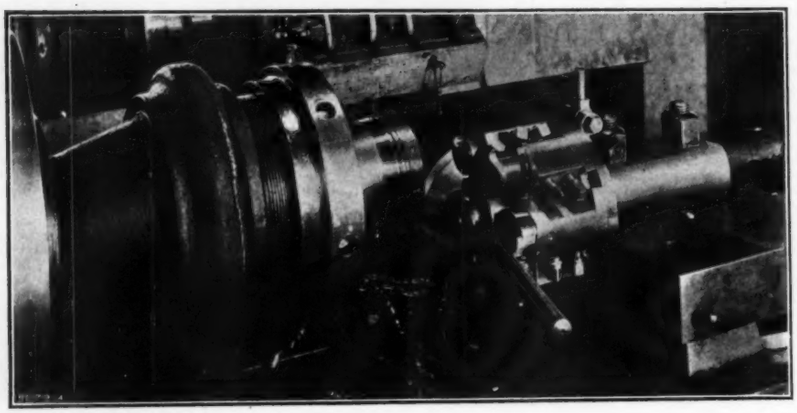


FIG. 1.

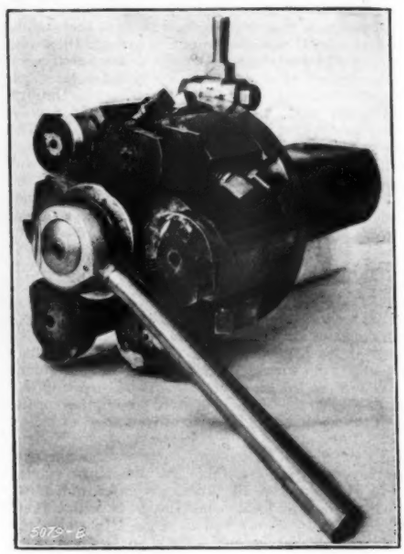
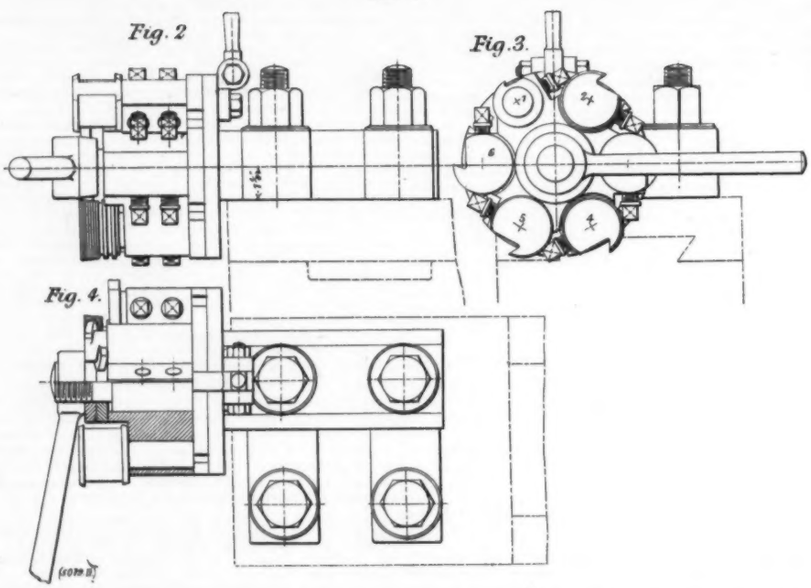


FIG. 5.



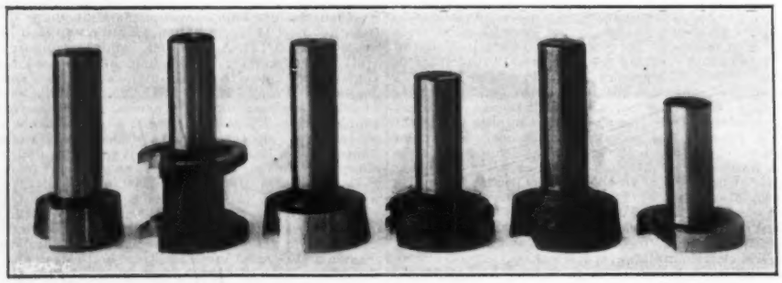
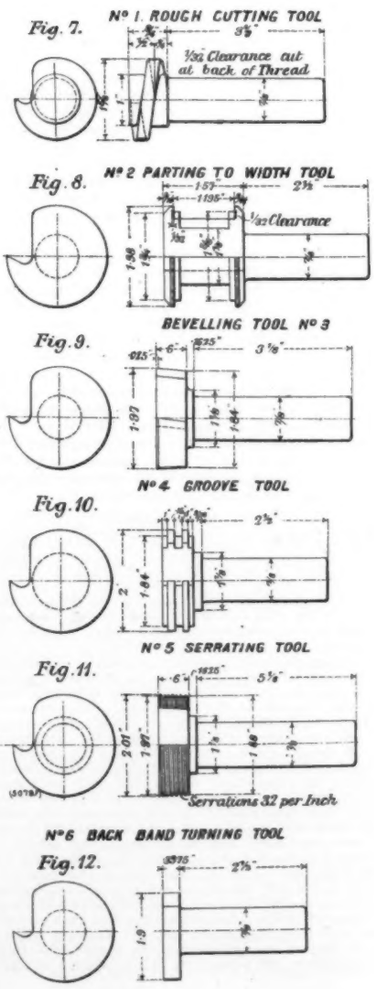


FIG. 6.



We illustrate on this and the opposite page the method adopted by Messrs. Mavor and Coulson, Ltd., electrical engineers, Glasgow, for turning copper bands on shells, which since its introduction has simplified the work and made it possible to use unskilled labour and women workers to a greater extent than formerly. Previously there was used a turret rotating on a vertical axis, but errors were difficult to detect in respect of the radius of the band when turned, and it was found impossible to obtain the correct diameter by using the dial on the screw. Moreover, the workers experienced a considerable degree of fatigue, owing to the continuous and close attention required to conform to the gauges, whereby the sight was strained. The essential feature of the new turret is that the correct diameters can be obtained by using the dial attached to the screw, and simplicity of adjustment greatly reduces the strain on the operator. As a consequence the average output has been increased by 90 per cent., with decreased personal concentration and fatigue. At the same time there has been a reduction of 30 per cent. in the proportion of shells spoiled. At Messrs. Mavor and Coulson's works the record for a woman worker, in a stretch of 10½ working hours, was the turning of 220 bands.

The drawings and photographs reproduced show in full detail the arrangement of the turret, which is adaptable to many types of machines. It is mounted

TURRET FOR TURNING THE COPPER BANDS ON SHELLS.

CONSTRUCTED BY MESSRS. MAVOR AND COULSON, LIMITED, ENGINEERS, GLASGOW.

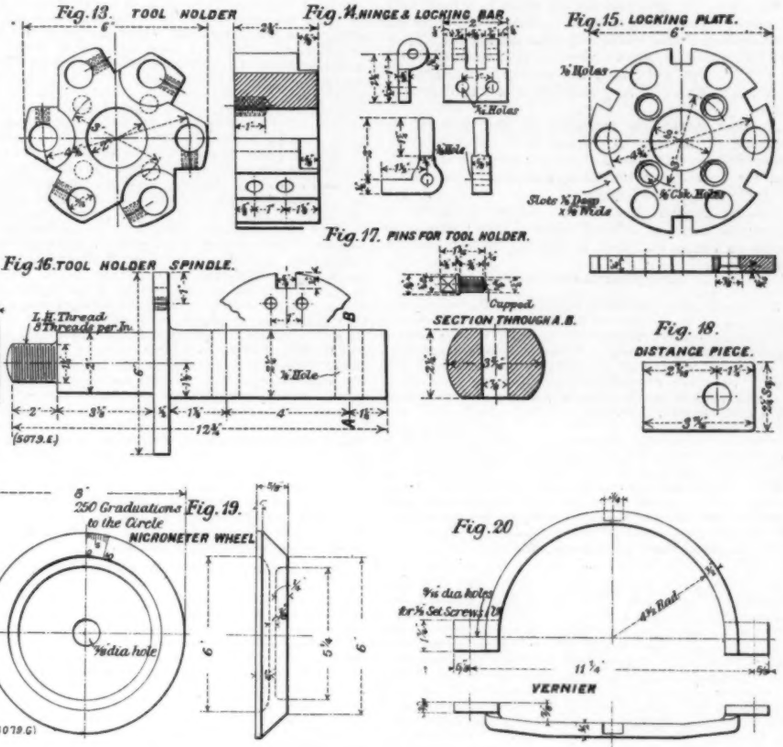


Fig. 13. TOOL HOLDER
Fig. 14. HINGE & LOCKING BAR.
Fig. 15. LOCKING PLATE.
Fig. 16. TOOL HOLDER SPINDLE.
Fig. 17. PINS FOR TOOL HOLDER.
SECTION THROUGH A.B.
Fig. 18. DISTANCE PIECE.
Fig. 19. MICROMETER WHEEL
250 Graduations to the Circle
Fig. 20
VERNIER

on a horizontal axis, so that any error in locating the tool is tangential instead of radial, as in the case of a turret mounted on a vertical axis. This makes it possible to use the screw on the cross-slide to give diameters within the limits of accuracy shown on the drawings of the shell. In order to bring the screw to the exact position a dial is mounted on the screw, and once the correct number is ascertained the same diameter can always be obtained by turning the screw until the dial registers that number. This avoids stopping the lathe and applying gauges to see that the correct diameter has been obtained. Six tools are used. These are shown mounted on to the machine in the perspective view, Fig. 1, while the plan, elevation and section of the assembled tools is given in Figs. 2 to 4, and in the perspective view, Fig. 5. The tools are shown separately in the perspective view, Fig. 6, and in the detail drawings, Figs. 7 to 12. The tools employed are; (1) for turning over the top; (2) for cutting the width; (3) for bevelling; (4) for grooving; (5) for serrating; and (6) for turning back strap. The tool-holder is shown in details, Figs. 13 to 18.

The saddle of the lathe is first set to the correct position to turn the band to width, and is not moved afterwards until the whole band is completely turned. The tools are arranged in correct axial position, and are merely fed in on the cross-slide to conform to the numbers of the dial; thereby is ensured a correct profile on the band. The tools themselves are turned in a lathe to the correct shape on the whole length of their circumference, with the exception of a small notch (as shown in the detail drawings) to form the cutting edge. Figs. 19 and 20 illustrate the micrometer dial fitted to show the position of the screw giving diameter required.

HYDRO-ELECTRIC POWER IN THE BLACK FOREST.—The work on the hydro-electric power station of the Murg River, in the Schwarzwald, one of the biggest German power schemes, has so far advanced that supply will be started before next winter, it is hoped.

ENGINEERING TRAINING.—The Board of Education has issued, at the price of 1d., a leaflet detailing the existing facilities provided for the training of apprentices and students in engineering; its purpose is to furnish in a brief compass a rapid survey of the more usual forms of technical instruction which are at the present time open to the engineering apprentice or student in this country.

SHIPBUILDING AND SHIPPING NOTES.

As soon as circumstances will allow a large new Norwegian steamer company is to be formed for the traffic between Russian Black Sea and Baltic ports. The capital is to be from 550,000*l.* to 850,000*l.*, and the Norwegian company will co-operate with a Russian concern with lines from the Black Sea, *via* Antwerp, Rotterdam and London to Norway; steamers of from 3,000 tons to 8,000 tons will be employed, and probably some smaller boats for the Baltic trade.

The Swedish steamer company Svenska Lloyd at the end of last year controlled 42 steamers of their own and of the Thule, the Svithiod and the Gothenburg-Manchester Line, and eight boats were in course of construction. Like most Scandinavian shipping companies, the Svenska Lloyd had done exceedingly well during 1916, paying a dividend of 30 per cent., the shareholders, in addition, obtaining new shares; large sums were applied to writings-off and reserve funds.

No Government measure has yet been prepared in Germany for the admittedly necessary State aid to the country's shipping after the war, but Dr. Helfferich has recently stated that he hoped it would be ready at the next meeting of the Reichstag. It will be a difficult problem to solve, for German shipping has, of course, suffered tremendously during the war, and in spite of an apparent official optimism, Hamburg takes the opposite view, the president for the Hamburg municipality stating recently that Hamburg's shipping and commerce had been almost completely destroyed.

At the Finnboda Yard, in Sweden, a new dock is in course of construction, the cost of which will amount to 1,100,000*l.* The length is 460 ft., but if necessary it can be extended another 33 ft. The breadth at the entrance is 75 ft., with a depth over the sill of 26 ft.

The Chinese yards, like all other yards, are extremely busy at present; a firm at Haugesund, Norway, has ordered three steamers from the Hong-Kong and Whampoa Dock Company, which, in addition, is building two cargo steamers for China and two for Siam. Norway has further ordered two steamers of 3,000 tons each and one steamer of 2,000 tons, the latter already launched from the Shanghai yard. The Yangtse Engineering Works, situated in the vicinity of Hankow, has recently built some gunboats, 105 ft. long, for the Chinese Government.

Although the Norwegian yards have a good market within their own country, not a few boats are being built for account of the other Scandinavian countries; thus Sweden is having a dozen steamers built in Norway and Denmark some two or three; the majority of these boats, however, will only be delivered next year or later. The ferro-concrete vessels continue to attract much attention in Norway, and a committee was some time ago appointed for the purpose of reporting upon the conditions under which the Fougner ferro-concrete vessels could be classified and registered. Pending the completion of this report the Government has granted the Fougner concern permission to build two motor vessels on trial. One of these vessels is 140 ft. long between perpendiculars and 27½ ft. broad. The engine-room and the accommodation for the crew are in the after part of the boat; the forward portion of the vessel contains the cargo space, with three winches. Considerable interest and curiosity is evinced in connection with this venture.

A large steamer company has been registered in Amsterdam under the style of Hollandsche Algemeine Atlantische Scheepvart Maatschappy, with a capital of 2,400,000*l.*, and the fleet will consist of 20 steamers, intended to be used for general traffic.

In Portugal the Government, it is understood, will establish a route between Portuguese and Brazilian ports; eight of the German boats will be put in this trade.

American shipyards are in several instances materially extending their plant; thus the Pennsylvania Shipbuilding Company, in Philadelphia, and the Pusey and Jones yard, in Wilmington, will, when the extensions are completed, be able to turn out a steamer every tenth day. Standard types will be adopted by both yards; the latter will go in for boats of 7,000 tons and 12,500 tons, and the Pennsylvania Shipbuilding Company for steamers of 4,200 tons.

Budapest will ere long boast a modern shipyard, which the Atlantica Company, of that city, is about to erect; it is intended not only to build steamers for the Danube traffic, but also small sea-going steamers.

Although the Austrian shipping concerns have fared very badly during the war, a considerable amount of shipbuilding is going on for their account. Thus the Priest Freie Schiffahrt Company has nine cargo steamers in course of construction, varying in size from 5,000 tons to 9,000 tons, the contract speed being 11 knots; the company's tonnage will thereby be increased to 125,000 tons. The Austrian Lloyd's has commissioned the building of a couple of sea-going steamers, besides some sloops and a tugboat. The Adria Steamer Company is having several boats built and further extension of tonnage has been decided upon, comprising fully a dozen steamers. The Hungarian-Croatian Company has ordered three boats, a passenger and cargo steamer of 1,000 tons, a cargo boat of 1,200 tons and a coasting steamer.

The Kallundborg yard in Denmark is engaged in the building of two new steamers, and at the Marstal yard, Denmark, the erection of additional buildings is being pushed ahead, necessary supplies of iron having now arrived.

A shipbuilding company has been formed at Franendorf, near Stettin, under the style of the Ostsee Werft, with a capital of 6,000,000 marks. Suitable sites have been secured on both sides of the Oder. A floating dock of 16,000 tons capacity has been ordered, and work will, it is expected, commence this autumn, although the installations can hardly be entirely completed till after the war.

COAL AND IRON IN NORTHERN PERSIA.—The mountainous district of Masandaran, in northern Persia, about 50 km. from the southern shore of the Caspian Lake, contains coal and iron ore, accessible by open working. Some of the coal is suitable for coking. There are brown ironstones (hydrated oxide); some distance further east, in the Elburs Mountains, hematite and iron clays are found. In drawing attention to these occurrences in a Russian journal, the *Naphtjanoje Djelo*, J. Mozieff points out that Masandaran is only 24 hours from the Baku oilfields, where the demand for iron is very heavy.

THE SULPHUR CONTENT IN COKE.—Observations made by J. R. Campbell, in Russia, on the sulphur content in coke and the influence of air and water on it, were described in a Russian technical journal last year, and are noticed in abstract by the *Chemiker Zeitung* of February 10, 1917. The sulphur is present as pyrite, as sulphate or as some organic compound. The FeS_2 loses nearly half its sulphur at relatively low temperature in beehive ovens; but the assumption that the hotter the oven, the more sulphur will be burnt to SO_2 or SO_3 is not justified, according to Campbell; nor is the sulphur removal more complete in beehive ovens than in by-product ovens, in which H_2S is generated, though more air is admitted in the former case. The quicker the coking, the less sulphur will be removed from the coke, Campbell finds; the sulphur of sulphates is not driven off by carbonisation. When the coke ashes are rich in oxides of iron, calcium and magnesium, a coke free of sulphur cannot be obtained. When the coke is quenched with water a smell of sulphuretted hydrogen is always noticed; but only a small portion of the sulphur can be got rid of by quenching, as experiments on a large scale proved. The removal of sulphur is more satisfactory when hydrochloric acid is added to the quenching water.

THE ARROWROCK DAM NEAR BOISE, IDAHO, U.S.A.

Of late years increased attention has been given to irrigation work in America and in various Colonial possessions of Great Britain, with the result that in many cases comparatively barren and useless lands have been changed into fertile and productive regions. Some account of the recently completed Arrowrock Dam near Boisé, Idaho, may therefore be of interest, since it is an example of how irrigation work may prove just as profitable in more northern districts as in southern regions like California, Arizona, New Mexico, &c.

Arrowrock Dam is located near Barber, on the Boisé branch of the Oregon Short Line, which forms part of the Union Pacific system, longitude 115 deg., W., latitude 45 deg., N. The State of Idaho is comparatively sparsely settled, and is chiefly devoted to agriculture, lumbering and mining. The following statistics covering the population of Idaho are taken from the "American World Almanack" for 1916:—

Population of Idaho.

1870	1880	1890	1900	1910*
14,999	32,610	84,385	161,772	325,594

* Last census.

The area of Idaho in square miles is 83,888, the extreme breadth from east to west is 305 miles, and the extreme length 490 miles; the area of Idaho is just a little smaller than England and Wales, whose area is 88,745 sq. miles. The population of Idaho per square mile is 3.9.

Preliminary work for the construction of the Arrowrock Dam was started in 1905, but the construction of the dam proper did not begin until 1911. Some idea of the magnitude of the task may be gained from the fact that, before work on the dam proper could begin, a barrage 12 miles down stream had to be constructed to insure the continuance of irrigation supplies already received from the river.

Incidental work included the erection of a model city for 1,500 inhabitants on the banks of the Boisé River, the construction of a standard-gauge railway 17 miles from Barber, on the Union Pacific system, to Arrowrock, and the erection of a 3,000-h.p. hydro-electric plant 12 miles down the river.

The excavation for the dam, of which we give two views on page 618, extended 91.5 ft. below the bed of the river to solid granite. The dam is anchored also in solid granite on both sides. All the work was done under the direction of Mr. F. E. Weymouth, supervising engineer for the United States Reclamation Service, with Mr. Charles E. Paul, construction engineer, in direct charge, and Mr. James Munn, as superintendent of construction.

Arrowrock Dam will provide water for the irrigation of 240,000 acres. It will store 244,000 acre-ft. of water, the drainage from 2,610 sq. miles of land. This body of water to be held in reserve would cover 381 sq. miles to a depth of 1 ft. The excavation work embraced the removal of 683,000 cub. yards of material; 610,000 cub. yards of concrete were used, with 1,350,000 lb. of reinforcing steel and 1,800 tons of structural steel. The dam alone cost 5,000,000 dols., the entire enterprise representing an expenditure of 12,000,000 dols. The measurements of the dam are as follow:—348.5 ft. high, 1,100 ft. long at top, 140 ft. wide at the bottom. It is crowned with a roadway 16 ft. wide. The dam is the highest in the world, being 98 ft. higher than the Flatiron Building, one of the tallest structures in New York City. Above the site of the dam a diversion tunnel 500 ft. long, with a cross-section 30 ft. by 25 ft., was bored through solid rock. Finally, cofferdams were erected on both sides of the site of the proposed irrigation dam.

Every gallon of the regular flow of the Boisé River throughout the irrigation season, from April 1 to October 31, had been appropriated by early settlers, and neither the Federal Government nor anyone else could infringe on these prior rights; but in the late winter and early spring, before water is needed for irrigation, the river is a torrent, and this valuable surplus simply rushed away year after year to swell the volume of the Snake and Columbia rivers, and in all these years there was lying right at hand a large body of land, parched and useless. This, then, was the problem of the Reclamation Service—to capture this flood and hold it in reserve until needed for irrigation in the hot, dry summer months.

In the basin of the Boisé River, above the Arrowrock Dam, there are approximately 3,000,000,000 ft. of merchantable timber, and the river furnishes the only practicable means of getting the timber out. This involves taking the logs around or over the Arrowrock Dam and delivering them in good condition in the river below. This problem has been solved by the construction of an apparatus that is capable of handling 60,000,000 ft. during the 60 days of each summer when the water is 45 ft. or less below the top of the dam; this equipment is at the extreme south end of the dam. With it the logs will first be taken out of the reservoir by means of a cable lift and deposited on a concrete deck on the top of the dam. From this deck they will be fed, one at a time, by a stop and loader, to power-driven spiked rolls which will take them across the dam and deliver them to a bull chain, which is provided with spurs or teeth to prevent the logs from sliding. This chain will take the logs at a speed of 85 ft. a minute down a slope having a fall of 62½ ft. to 100 ft., and will finally deposit them in a gravity-chute, through which they will slide down into the river below.

Another important accessory to the dam is the spillway at the side to dispose of the surplus water when the reservoir is full. This has a length of 402 ft., and for this excavation it was necessary to remove 300,000 cub. yards of rock.

Already Arrowrock Dam has proved its worth by saving the crops on 100,000 acres of land; this alone would be almost sufficient to pay for the total cost of the work.

JUNIOR INSTITUTION OF ENGINEERS.—The committee appointed by the council of this Institution has issued a communication to invite comments upon a draft scheme for the formation of a "cadet" class of associate members, to consist of youths of 15 years of age and over who intend to enter the engineering profession. Further particulars on the subject can be had from the secretary, 39, Victoria-street, S.W. 1.

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has issued a new list (No. 29) of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C. 2.

INQUIRY UNDER BOILER EXPLOSIONS ACTS.—A formal investigation was held in the Town Hall, Rotherhithe, London, S.E., on May 8, 9, 10, 11, 15, 16, 17, 18 and 22, into the circumstances attending the explosion of the generator in connection with the refrigerating and ice-making plant of the Bermondsey Infirmary, Rotherhithe, S.E. The generator, which was used for the distillation of ammonia gas, consisted of two welded drums, 1 ft. 8 in. in diameter by 6 ft. in length, connected by piping and heated internally by steam in coils, and externally by two gas burners. The commissioners found that the explosion of the generator was due to defective welding of the longitudinal seam: the shell was weakened by the bad weld and stresses set up by distillations, which were exceptionally severe owing to sudden and wide changes of temperature. The generator had been welded by the oxy-acetylene process, which the commissioners condemned for boilers under tension, and the type of safety valve in use was also condemned. The commissioners further found that the responsibility for the explosion rested upon the makers and vendors of the plant, and on certain of their officials, and upon the owners of the plant and one of their officials, and made orders, amounting to 320*l.*, to be paid by the implicated parties, towards the costs of the investigation.

INDUSTRIAL EXTENSIONS IN GERMANY.—The Rhenish Steel Works, Duisburg, have decided to increase their share capital by 12,000,000 marks, from 48,000,000 marks to 60,000,000 marks. The reason is the common desire of German iron and steel works to extend their possessions of coalfields. The Rhenish Steel Works have for several years owned the Rheinberg coal deposits, but these yielded mostly bituminous coal, and on account of the war it has become necessary to acquire coalfields containing gas and flame-coal. For this purpose the Brassert concern has been secured, the coal from which is said to be admirably suited to meet the wants of the steel works. All the departments of the company are busy to the utmost with direct or indirect military contracts. The Allgemeine Elektricitäts Gesellschaft is about to increase its share capital from 184,000,000 marks to 200,000,000 marks, the new 16,000,000 marks being required in connection with the company's dealings with the Berlin Electricity Works. The A.E.G. holds four-fifths of the shares of these works, and the transaction is connected with the A.E.G. taking over the shares now held by the works in question, with an advance to the large Elektrowerke at Bitterfeld. The Bitterfeld Elektrowerke principally supplies energy to the Imperial works for the manufacture of nitrate of lime. The plant of the Bitterfeld power station leaves nothing to be desired, but no secret is made of the fact that the financial results are not entirely satisfactory. The greater part of the energy generated having been disposed of at fixed and very moderate prices, the result is not likely to improve during or immediately after the war. The Leipsic Overland Power Station at Kulkwitz is increasing its capital by 4,000,000 marks, so that it now amounts to 14,000,000 marks; the company, which is closely connected with the Company for Electrical Undertakings in Berlin, is contemplating several extensions. The North German Wagon Company Bremen, which increased its capital in 1915 by 500,000 marks and in 1916 by 750,000 marks, is about to undertake a further increase of capital, this time amounting to 1,250,000 marks. The German Cable Works Company at Lichtenberg, near Berlin, which some years ago increased its capital by 1,750,000 marks, is about to further increase the share capital by 750,000 marks.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The position from the standpoint of manufacturing fuel is one of increasing difficulty. The demand is continually on the advance, and hard-coal pits are working at the maximum pressure to meet requirements. Nevertheless there are many arrears mounting up, and works that have no railway facilities, or indifferent ones, are apt to suffer rather seriously from the tightness which prevails. In some respects there is a distinct improvement in the way in which railway companies are dealing with the empty wagon problem, but, on the other hand, the time taken for the deliveries is as yet much above the normal. The most striking factor about the situation is that, from the official point of view, there can be no alteration for the better for some time ahead. Little or no fuel is obtainable outside contract account. Best steam hards are almost wholly absorbed by contractors, while nuts are not even sufficient to meet the present-day demand. Cobbles have an easier tendency, and slacks have also become more or less easy, though buying from the Lancashire quarters is still on a heavy scale. The market for steel-making cokes is brisk. The chief feature in the house-coal section is the question of a municipal coal supply in Sheffield for the coming winter One has been arranged in Rotherham by the local corporation, and the Sheffield body are anxious to follow suit on behalf of the poorer sections of the community. Local dealers and merchants are not taking kindly to the proposal, and there is some rather pointed criticism. At present no details have been arranged, and the matter is in the hands of a joint committee of the local authorities and the merchants' association. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at the pit.

Iron and Steel.—The colder weather has been marked by an appreciable increase in the output of the furnaces, rolling mills and forges, and this is expected to result in the month of June having a much better record than the opening tropical days promised. All the steel firms are working at the maximum, and there are no immediate signs of a respite. If the demand for steel for one particular production shows a temporary reduction there is almost certain to be a corresponding increase in another. In essential productions these fluctuations seldom take place, though there can be no disguising the fact that nothing like the same quantity of steel is being converted into shells as formerly was the case. Symptomatic of what the future may have in store is the great activity which is to be found in all shops that have aeroplane work on hand. Messrs. Cammell Laird and Co. and Messrs. William Jessop and Sons have recently received very large orders for certain aeroplane parts, chiefly cylinders. Delivery is demanded within a very short space of time. The alloyed steels for motor-car work, tanks, &c., are also in great request, and the output is on a proportionate scale. Repair work in one direction or another is becoming increasingly heavier, with corresponding added pressure on the furnaces for material and the engineering shops for the skilled labour. This line rivals the shipbuilding work for importance, but the latter is still the heaviest single task the city is engaged with at the present day. Tool-makers have been favoured with more Government orders, the greater proportion of which will be sent to the shipyards. All this business is reflected in the very pronounced tightening-up in the metal market. It is interesting to note that Swedish material is not now so scarce, thanks to the arrival of one or two important cargoes, but inland makes of pig are harder to get than at any time previously this year, and makers contend that there is good ground for the advance in tariff, which the consumers are understood to still oppose. Both forge and basic—either Derbyshire or Lincolnshire brands—sell with ease at the highest figures, but foundry sorts are in no way equal to the requirements of the Sheffield firms. Hematites arrive in good numbers at local works, and special qualities seem to be quite sufficient for immediate needs. Both Bessemer and Siemens billets are unobtainable at the figures nominally quoted, and they are rising in price for long-dated contracts. In the lighter trades it is noteworthy to find that no less than 90 per cent. of some classes of cutlery and plate are for export. The general trend of overseas trade is upward, but there is a limit to the capacity of production when staffs are so depleted. Recent indents are for saws, tools, files, sheep shears, machinery, high-speed tool steel, vices, anvils, springs, machetes and steel.

BEEHIVE COKE OUTPUT IN THE UNITED STATES.—We read in *The Iron Age* that the beehive coke production in the United States in 1916 was the largest ever recorded. Official figures of the United States Geological Survey place the output at 35,464,224 tons, valued at 95,468,127 dols. This is an increase of 7,955,969 tons, or 29 per cent. over that of 1915, and larger by 38,522,584 dols., or nearly 68 per cent. in value. The average value of the coal used in 1916 was 1.26 dols. per ton, an increase of 21 cents over 1915, and the average value of the coke last year was 2.69 dols., an increase of 62 cents. There were 65,605 active beehive ovens in 1916, as against 48,985 in 1915, an increase of 16,620. The idle ovens were 25,976, as compared with 44,125 in 1915. Abandoned ovens were 2,265, of which nearly 1,800 were in Pennsylvania. No new ovens were built.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Conditions in the Scotch steel trade are still maintained at very high pressure, the demand for steel of all grades being more than equal to the available supply, notwithstanding the fact that every bar and plate mill is constantly running to its utmost capacity. The increasing requirements of Government have made further restrictions necessary, with the result that less material can be set aside for the ordinary home or export trade, only shell discard steel being readily available for these purposes. Then, too, for steel of this grade a licence is more easily obtained; thus rendering its export a matter of not too much difficulty. All these demands have made for a greater or less scarcity of finished steel, The activities of the Shipping Controller, and those associated with him in the building and equipping of vessels required to take the place of those put out of service through the exigencies of war, have greatly added to the pressure in steel-making establishments in the West of Scotland, as elsewhere, and it is satisfactory to know that the results achieved have fully compensated for the efforts expended. Since the inauguration of the scheme the demands made by the Clyde yards have been insatiable, sections, plates and shapes of all kinds being in urgent request. Prices keep steady.

Malleable Iron Trade.—Nothing could exceed the present activity in the malleable iron trade, makers being fully employed alike in the iron and steel departments. While general business is greatly restricted, there remains an ample sufficiency of Government orders to keep things moving at high pressure for a considerable period ahead, practically the entire output being absorbed. Of course the Government restrictions on the export of steel have closed this door for some considerable time, and now the iron products are coming under the same ban. Prices show no change.

Scotch Pig-Iron Trade.—The excessive demand for pig-iron keeps producers as actively employed as ever since the outbreak of war—every brand being in keen request. The entire production of hematite continues to be taken up by the local steel works, but as little or none of the output is now available for any other consumer than the home Government or some of the Allies, private buying is quite out of the count. At the iron works forge quality is much in request, and with certain brands of foundry grade becoming scarcer, an increase in price has taken place during the past week, a shilling or so per ton having been added to the f.o.b. rate.

ROYAL SOCIETY OF ARTS.—The annual general meeting of the Royal Society of Arts was held on Wednesday, the 27th inst., at the close of the 163rd session of the society, Dr. Dugald Clerk, F.R.S. (chairman of the council), in the chair. H.R.H. the Duke of Connaught, K.G., was re-elected president of the society, and amongst the new vice-presidents elected was Field-Marshal Sir Douglas Haig, who is a Fellow of the society of over twenty years' standing. Sir Henry Trueman Wood was re-elected secretary, but it was announced that he had tendered his resignation to the society to date from September next. He has held the secretaryship since 1879. The usual report of the council announced, amongst other matters, that the society's Albert medal had been awarded to Mr. Orville Wright "in recognition of the value of the contributions of Wilbur and Orville Wright to the solution of the problem of mechanical flight." Silver medals for papers read during the session had also been awarded to Dr. A. C. Benson, the Master of Magdalene College, Cambridge; Mr. F. A. Hocking; Sir C. Arthur Pearson, Bart.; Mr. Leslie Urquhart; Professor J. A. Todd; and Captain Philippe Millet. The report also stated that the society had had, despite the war, a successful and prosperous session; the financial statement showed practically no deficit; and the number of subscribing Fellows had been well kept up.

SWITZERLAND AND THE MANUFACTURE OF DYES.—The fact has been published in Switzerland, according to *The Textile Mercury*, that overtures for the purchase of Swiss colour works have been made both from English and German sources, and that, temporarily at least, both have been declined. A delegacy from England visited Basle last year, and although the failure to come to terms was a disappointment at that time, the Swiss reasons for maintaining independence were appreciated. Swiss help seemed to promise to the infant British industry experience in which we were more lacking then than now. To German colour makers the acquisition of Swiss works appeared no doubt as a ready means of preventing English progress and of bolstering their own position after the war. The value of Swiss help in keeping British dyers going at a critical time in their history has always been acknowledged, and certainly will not be forgotten. It is the opinion in Basle that the day of very high prices for dyestuffs is over, and so we may all judge. Cost is very much a matter of the scale of production, and the scale is not in this case limited to the production of dyes. One has only to look round to see how enormously the war has stimulated the recovery of tar products, the manufacture of reagents indispensable to colour manufacturers, and the construction of new chemical plants. Given large-scale working and the systematic exhaustion of by-products, British and American colours will be cheap. This prospect has its influence naturally upon Swiss minds as well as German ones, and at this time nobody should fail to see that it must be the aim of every major country to maintain within its own boundaries factories which can earn their keep in peace time by making dyes, and can turn out an endless stream of high explosives in case of war.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Firmness continues to characterise Cleveland pig-iron, though the supply is plentiful, so much so that traders anticipate release of fair quantities for export in the near future, and as the tonnage situation is becoming better there are prospects of shipments showing a good deal of improvement. Demands from France and Italy are continuously heavy, and occasional efforts are made to negotiate on behalf of other countries, but with very rare exceptions business with neutrals is impossible. Transactions on home account have recently been on a very limited scale, but with the July allocations, which promise to be of a very liberal kind, activity over the next week is assured, notwithstanding that buying for customers North of the Tweed threatens to be checked by the July holidays. Values of Cleveland pig-iron are well maintained. For home consumption No. 3, No. 4 foundry, and No. 4 forge all stand at 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; and for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.* Several makers have still rather considerable stocks of forge iron, and some of them are understood to have sold to home customers at a little below the recognised market quotation.

The Public Warrant Stores.—The quantity of iron in the public warrant stores is the smallest recorded since Messrs. Connal took over the stores from the old Cleveland Company in 1877, and has fallen so low that the disappearance altogether of the stock would cause little surprise. Only 1,358 tons, all of which are No. 3 Cleveland pig-iron, remain in the stores. So far this month only three changes in the stock have been recorded, 500 tons having been taken out on the 7th inst., 8 tons having been withdrawn on the 11th, and 7 tons taken out on the 25th—a total reduction during June, to date, of 515 tons.

Hematite Iron.—Demand for East Coast hematite iron, both on home and foreign account, is as insistent as ever. Official organisation continues to assure sufficient supplies to customers reachable by rail to meet all legitimate needs, and to leave a surplus for shipment abroad. There are gratifying reports of more inclination to put through foreign transactions, and of one or two applications for export licences in connection with new business, but several makers still hesitate to book orders for abroad on terms obtainable. Meanwhile shipments, under running contracts, are understood to be proceeding as expeditiously as circumstances permit, and to be fairly good under the conditions prevailing. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 142*s.* 6*d.* for export to Italy.

Coke.—Notwithstanding plentiful supply, coke keeps its value well. Local needs are heavy, and descriptions required for the blast-furnaces continue to realise full rates, average qualities selling at the fixed maximum of 28*s.* at the ovens, and low phosphorus sorts remaining at the limitation figure of 30*s.* 6*d.* at the ovens.

Manufactured Iron and Steel.—The manufactured iron and steel industries present few new features. To cope with Government needs and shipyard demands works are running at high pressure, and as requirements of these branches absorb almost the entire production, little opportunity is afforded for the transaction of ordinary commercial business. Prices are very stiff. To home customers common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

Cleveland Ironstone Miners' Wages.—Members of the Cleveland Ironstone Miners' and Quarrymen's Association are making a claim on the mine-owners for a further increase in the war bonus, and are also pressing for an arrangement with the employers for the payment of uniform extra rates for working on holidays during the period of the war, and for dealing with the hours of surface workers on those days.

NEW OIL FUEL FOR MOTORS.—By impregnating crude oil with certain organic compounds a new fuel for crude-oil engines can be obtained—according to the German periodical *Motor*—which contains 82.96 per cent. of carbon, 10.05 per cent. of hydrogen, 2.85 per cent. of oxygen, and 0.14 per cent. of sulphur. It is not stated what the missing 4 per cent. consists of, but all the constituents are said to be combustible, and the ignition-point of the fuel is to be below 30 deg. C.

SWISS IRON MINES AT THE GONZEN MOUNT.—The iron mines of the Gonzen were exploited in the period 1823 to 1878, and the pig-iron gained in charcoal furnaces was further treated in the iron works at Laufen, near Schaffhausen, and Littau, near Lucerne, which had a reputation for the excellent quality of their iron. The mines were then abandoned owing to the keen competition from abroad. In view of the chances of electro-metallurgical processes and the present difficulties Messrs. Sulzer, of Winterthur, and the Eisen- und Stahlwerke G. Fischer, of Schaffhausen, have combined with Mr. O. Neher, of Mels (Canton St. Gallen) to form a Company for the purpose of investigating whether the iron mines are sufficiently rich in ores to justify the financial risk of new operations and works.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The position of the market has undergone no material change. The supply of tonnage continues irregular; it is only with extreme difficulty that the collieries are able to obtain the necessary supplies of empty wagons, and in some districts intermittent stoppages have been experienced. In these circumstances it is natural that prices should be weak for spot shipment, and there has been very little disposition shown to sell ahead, and individual stoppages are likely to continue at the collieries. There have, however, been no changes of note in the quotations, though these are now more or less nominal. There does not seem to be a prospect of an immediate change for the better.

Newport.—A quiet, though a shade steadier, tone has generally characterised the market. Very little business, however, has been transacted, and it is only in those cases where the collieries are well stemmed that direct quotations are maintained, but middlemen with stocks on hand have been offering at appreciably lower figures than the accepted quotations to shippers with tonnage in dock. Western Valleys this week rule nominally up to 28*s.* 6*d.*, and Eastern Valleys are also up to that figure for the best sorts, and to 1*s.* lower for other descriptions, while small coal and coke are weak.

The Supply of Pitwood.—The Pitwood Committee, formed under the scheme suggested by the Deputy Controller of Import Restrictions, has now set to work to make the necessary allocations of the pitwood imported from France and Portugal to the Bristol Channel. The committee consists of pitwood importers to the Channel from those two countries in 1914 and 1915. The duty of the committee, which is given a general licence, is to grant subsidiary licences and allocate proportionate quantities to importers other than those which supply the Admiralty. For practically three months the ex-ship price of imported timber has been stationary at 75*s.*, but this week supplies have been obtainable at from 2*s.* 6*d.* to 5*s.* under that figure. This is due to a temporary excessive margin of supply—a position of affairs which has not been experienced for a long while, as hitherto the shortage of supplies has been the cause of grave anxiety.

The State Control of Mines.—Negotiations are still proceeding in connection with the State control of profit and price schemes. An important meeting of the chairmen of Welsh colliery companies was held this week. Official details of the scheme are still being withheld, but on the stock market colliery shares command enhanced figures, and there prevails general confidence that the scheme will prove fairly equitable.

Rumoured Amalgamations.—During the last few days currency has been given on the Cardiff coal market to rather extraordinary rumours regarding prospective amalgamations of very large Welsh colliery concerns. These rumours are to the effect that the Powell Duffryn Company and Ocean Wilsons, Limited, have entered tentatively into an agreement which will become operative after the war, and that in its final form this would involve the absorption of the Cardiff Collieries, Limited, and the Rhymney Iron Company. Such an amalgamation would form a combine with a nominal capital, including debentures and preference shares, of nearly 8,500,000*l.*, with an annual output of 9,350,000 tons of coal, while the actual market value of all the shares of the companies concerned would aggregate something like 15,000,000*l.* Though credence is given in some quarters to the suggestion that there is real foundation in fact for these rumours, they are generally discounted; and at any rate there is no confirmation forthcoming, so far, from any responsible quarter.

BOLIVIAN TUNGSTEN AND ANTIMONY.—The tungsten output of Bolivia for 1915 is reported at 792.5 metric tons, says *The Iron Age*, New York, an increase of 516.5 tons, or 349 per cent., over that of 1914. The United States took 436 tons and Great Britain 357 tons of the 1915 output. The Bolivian antimony production in 1915 exceeded all expectations, amounting to 17,923 tons, as against 186 tons in 1914. Great Britain took the larger part of the 1915 output, 16,184 tons, 1,589 tons going to the United States.

GLOVER'S ALMANAC.—We have received from Messrs. W. T. Glover and Co., Limited, the well-known electrical wire and cable makers, of Trafford Park, Manchester, their sixteenth almanac for the twelve months from July 1 of the current year. They state that the almanac is compiled, as it has always been, with the idea of bringing much useful information under the notice of busy engineers. A glance at the present issue is sufficient to show that it will meet its object, as the former ones have invariably done. The information is enlivened as usual by a number of very clever pictorial skits.

LIGNITE IN THE FAROE ISLANDS.—The fuel famine has again attracted the attention of interested parties to the lignite deposits in the Faröe Islands, and in some quarters an optimistic view is taken as to their value and importance under the present exceptional conditions. The aggregate capacity is estimated at 24,000,000 tons, and the working of at least the first 200,000 tons will neither entail ventilating nor pumping installations of much moment, nor necessitate a staff of skilled hands being engaged. Transport by rope line or ordinary railway to a safe anchorage should not present any special difficulty. The quality is admittedly good, and the lignite can perfectly well be used for the production of gas.

THE ARROWROCK DAM, NEAR BOISÉ, IDAHO, U.S.A.

(*For Description, see Page* 616.)

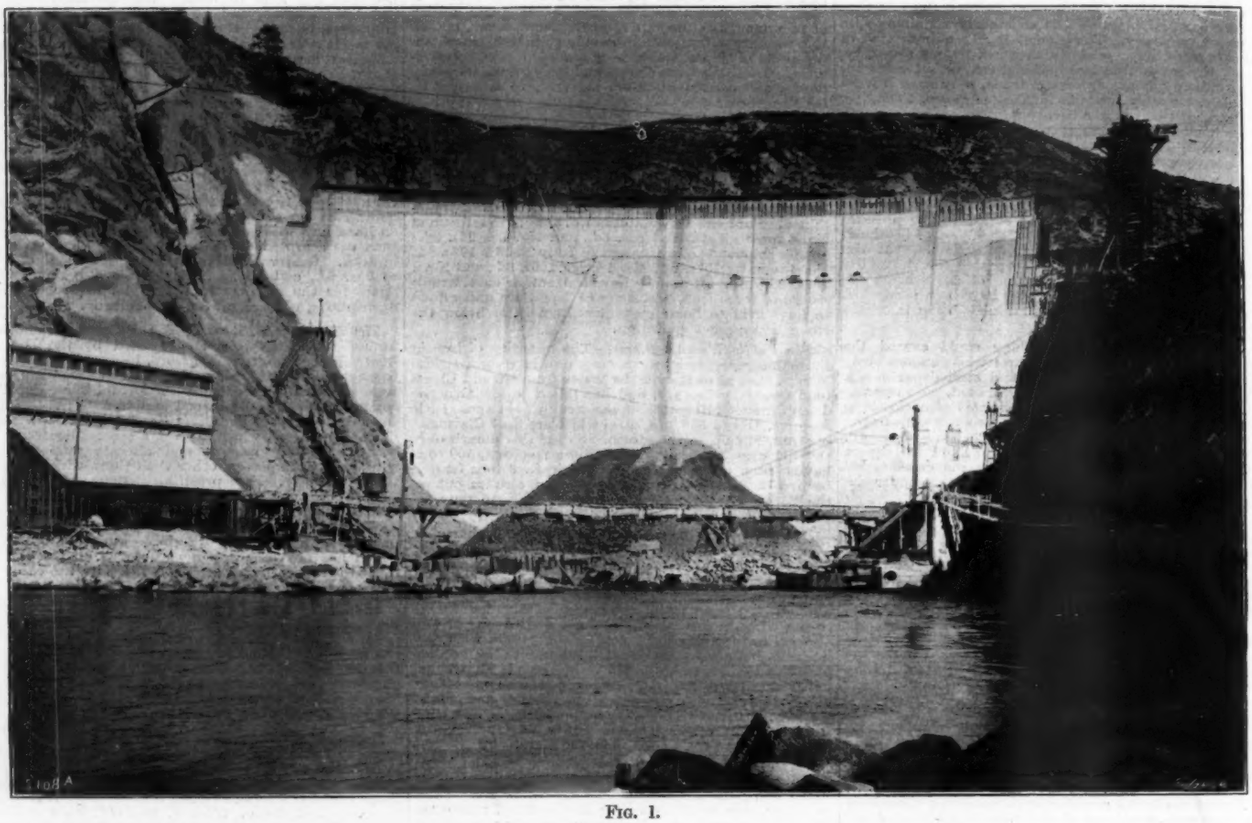


FIG. 1.

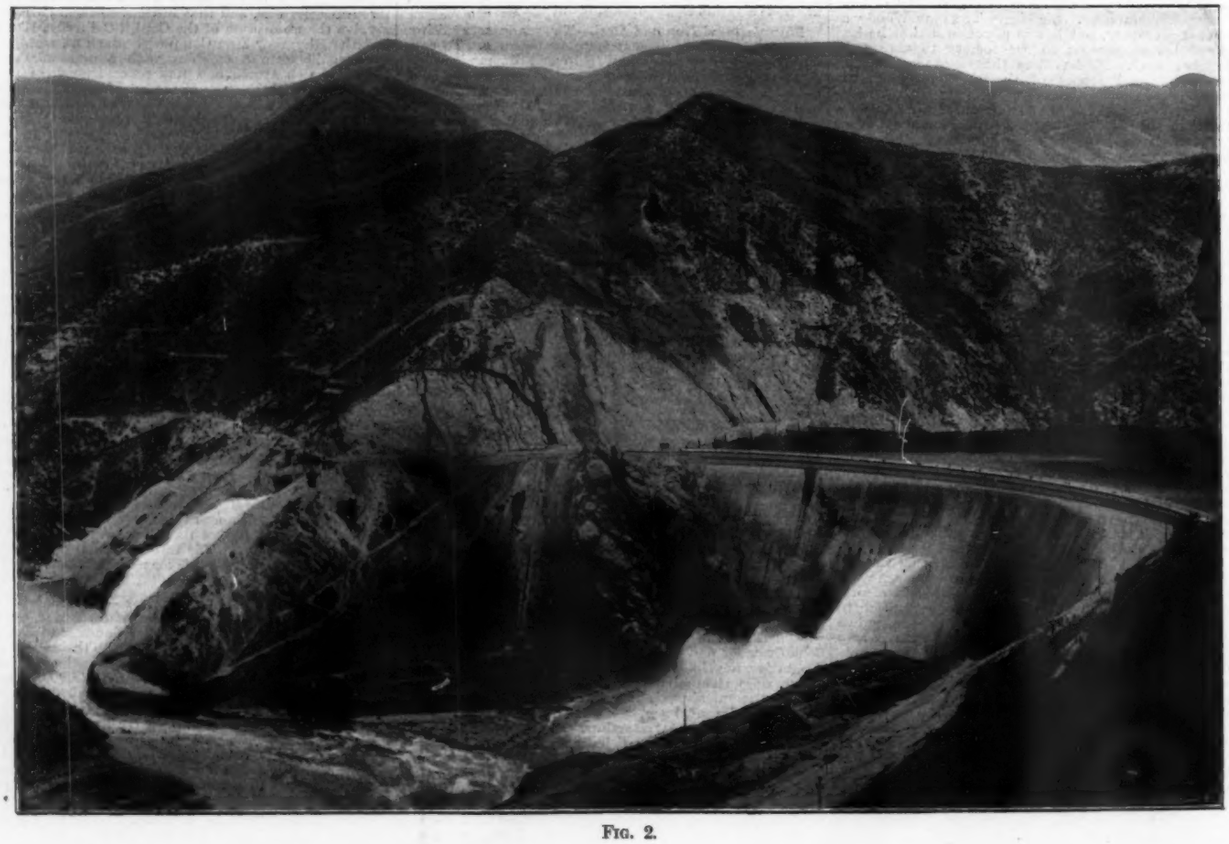


FIG. 2.

GEARED TURBINES FOR THE TWIN-SCREW CUNARD LINER "AURANIA."

CONSTRUCTED BY THE WALLSEND SLIPWAY AND ENGINEERING COMPANY, LIMITED, WALLSEND-ON-TYNE.

(*For Description, see Page* 609.)

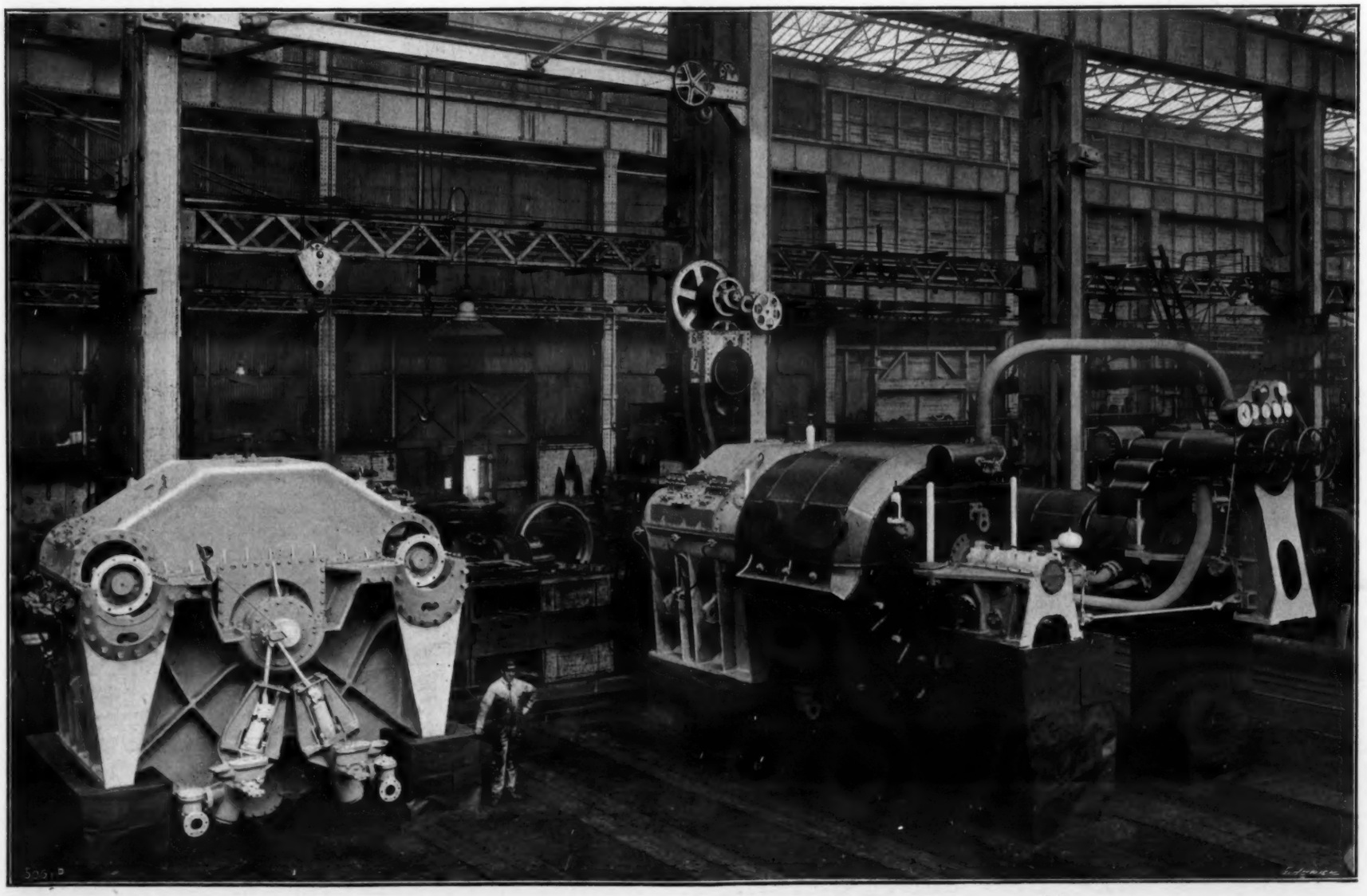


FIG. 14.

(*To face page* 610.)

GEARED TURBINE TWIN-SCREW CUNARD LINER "AURANIA."

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LIMITED, SHIPBUILDERS, WALLSEND-ON TYNE.

(*For Description, see Page 609.*)

Fig 1.

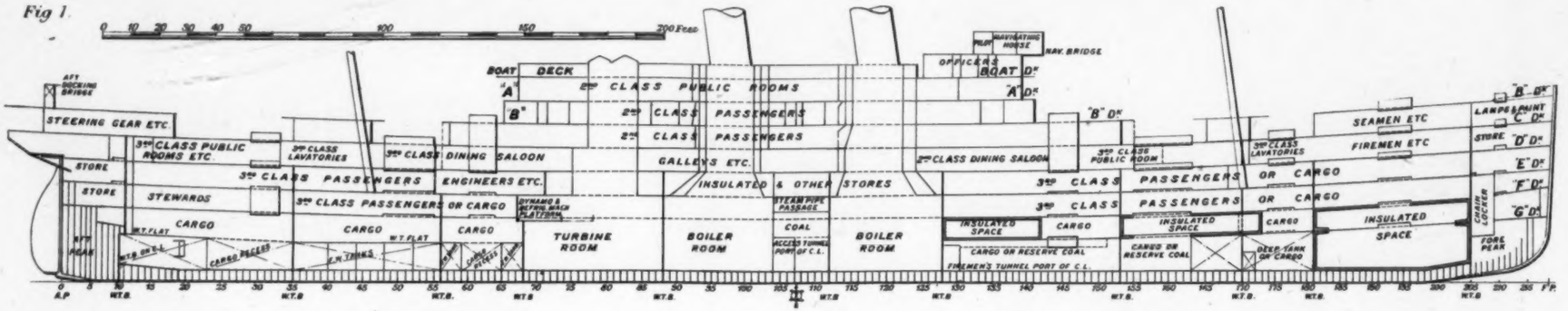


Fig.2. NAVIGATING BRIDGE.

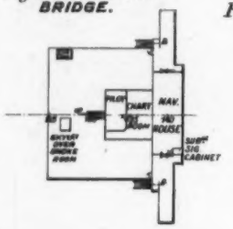


Fig.3. DOCKING BRIDGE. (AFT)

Fig.4. BOAT DECK.

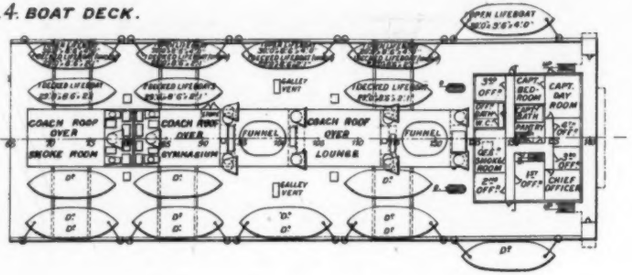


Fig.5. "A" (PROMENADE) DECK.

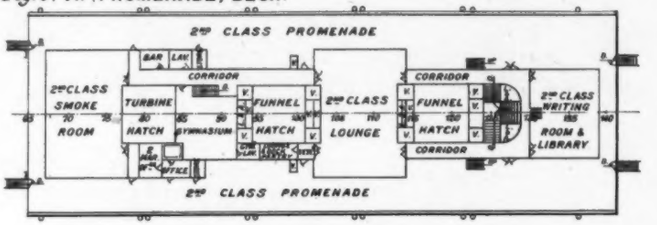


Fig.6. "B" (BRIDGE) DECK

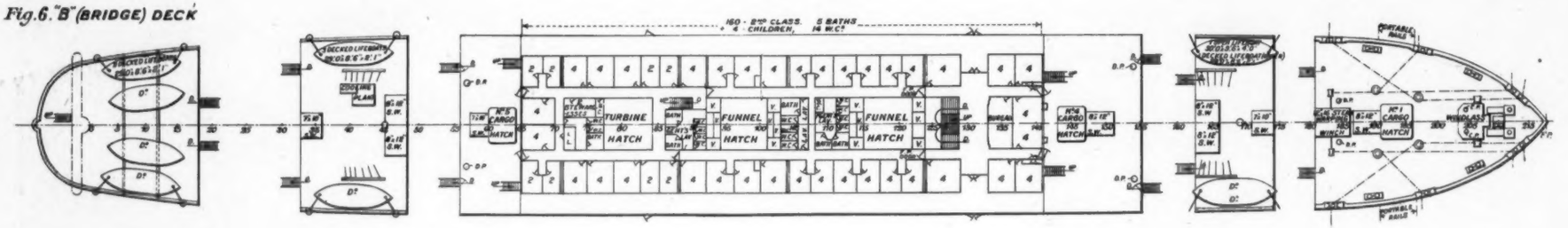


Fig.7. "C" (SHELTER) DECK

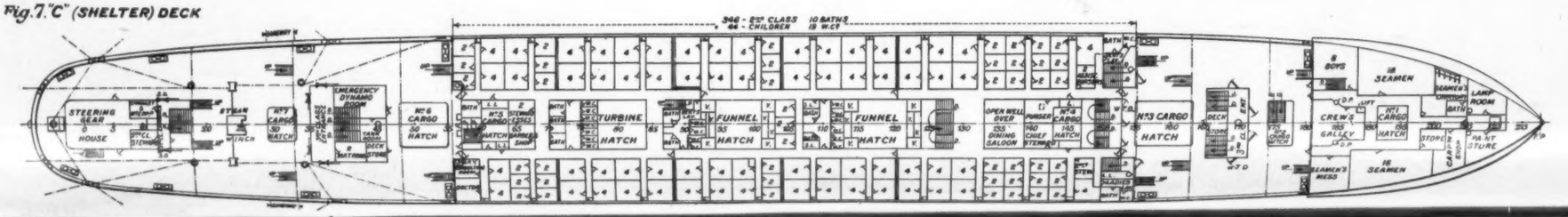


Fig.8. "D" (UPPER) DECK

Fig.8. "D" (UPPER) DECK

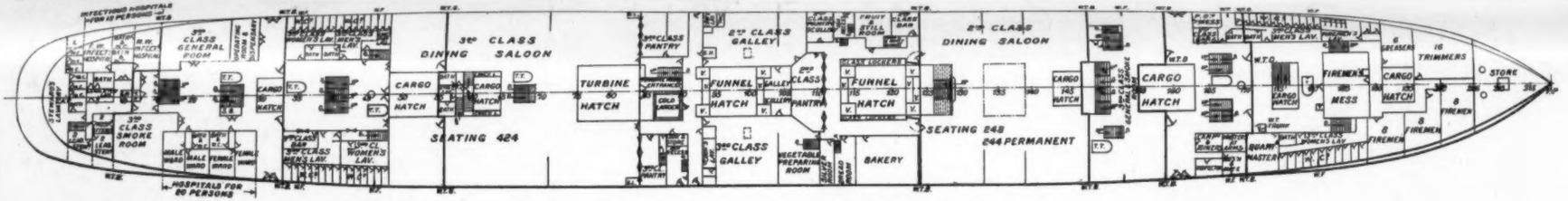


Fig.9. "E" (MAIN) DECK.

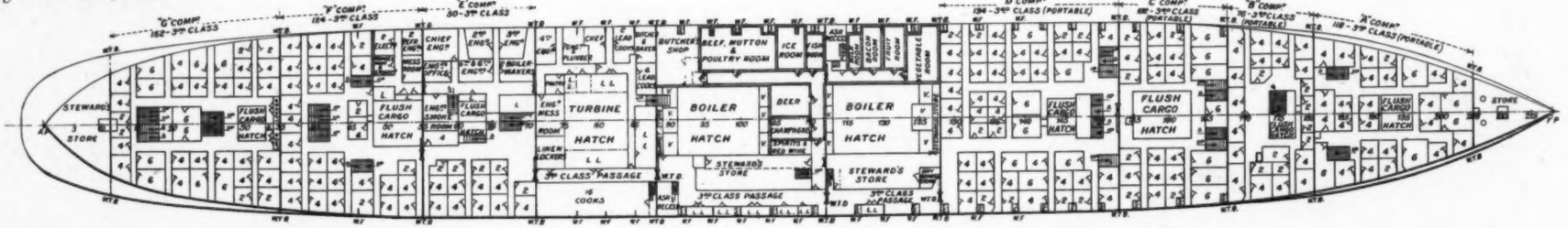


Fig.10. "F" (LOWER) DECK.

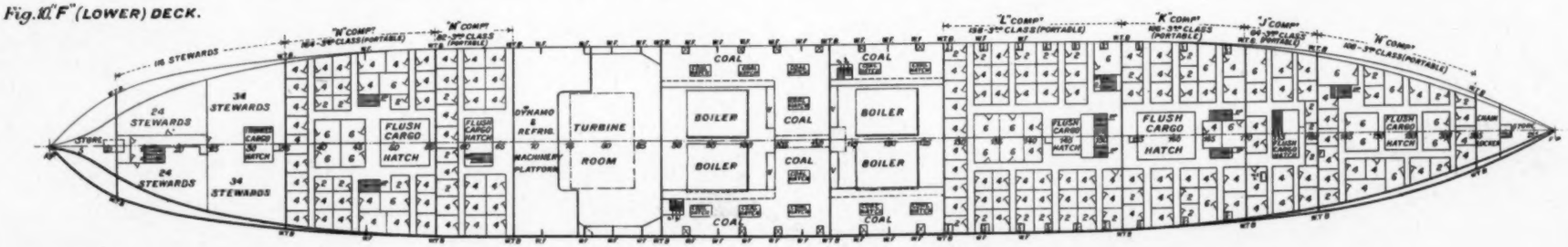


Fig.11. "G" (ORLOP) DECK.

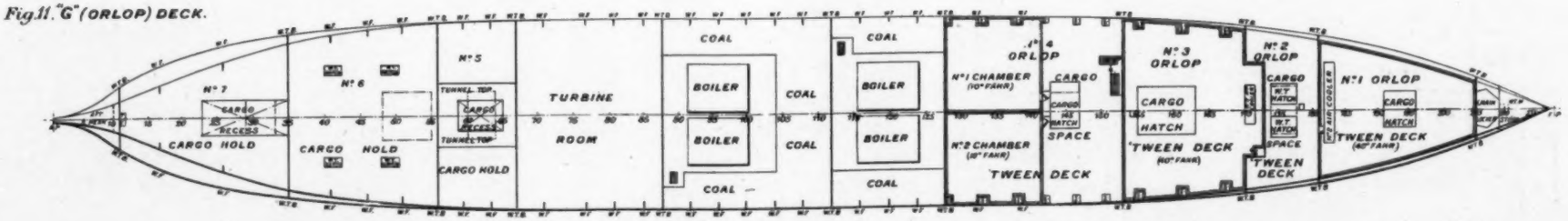
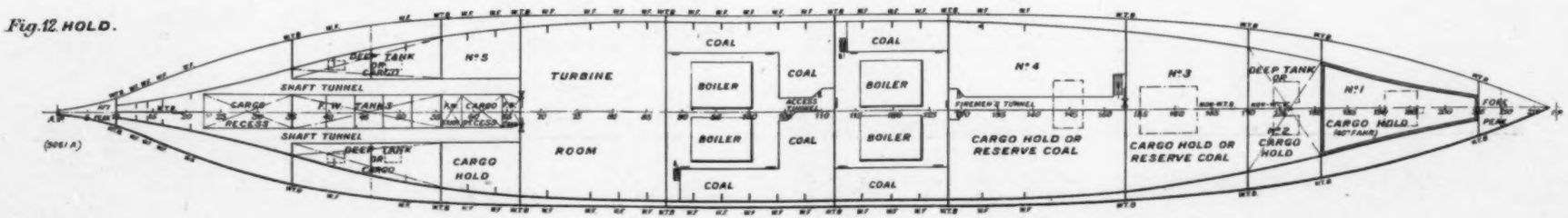


Fig.12. HOLD.



GEARED TURBINES FOR THE TWIN-SCREW CUNARD LINER "AURANIA."

CONSTRUCTED BY THE WALLSEND SLIPWAY AND ENGINEERING COMPANY, LIMITED, WALLSEND-ON-TYNE.

(*For Description, see Page* 609.)

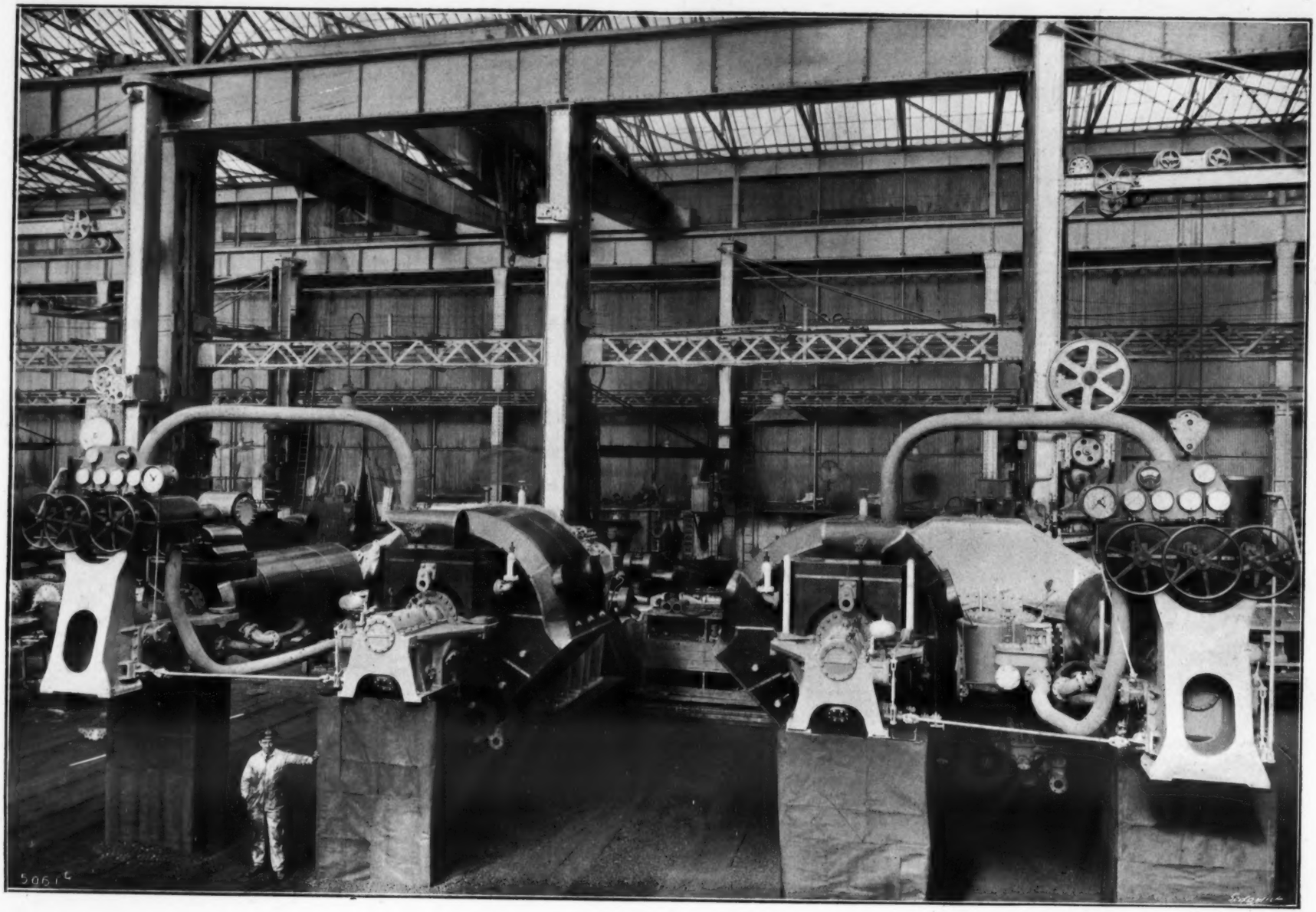


Fig. 15.

(*To face page* 611.)

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

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TELEPHONE NUMBERS—3063 and 8598 GERRARD.

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With One Two-Page Plate and Two One-Page Plates of the GEARED TURBINE TWIN-SCREW CUNARD LINER "AURANIA."

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, JUNE 29, 1917.

THE BRITISH TRADE CORPORATION.

A LONG step towards meeting the fierce competition of foreign traders, which was assuming such huge dimensions when the war broke out, was taken when it was announced that a charter had been granted for the establishment of a new financial institution whose sole and distinct object was to assist traders by advice, special facilities and any means in its power to carry on their commerce under the most favourable conditions.

Long before the war complaints had been made with ever-growing weight that foreign competitors had captured markets in which we were formerly supreme, that they dominated industries by their syndicates and cartels, and that they had practically monopolised many technical processes, even though the original discoveries which made the processes a commercial success were the result of British labours.

Now it must be remembered that our competitors had had to establish their commerce in the teeth of our complete possession of the world's markets and of our tremendous financial resources, both of which conditions were the result of the great industrial revolution in the early part of the last century, and of the fact that we alone had been able to supply the world's demands which arose at the end of the Napoleonic Wars and later.

Because of this predominance, coupled with the fact that the natural wealth of their own countries was so small, it was absolutely necessary, for competition to be successful, that every means should be adopted whereby trade could be secured. To achieve this end a great body of cheap labour was created, a project which presented no great difficulties, largely owing to the low standard of comfort of living of the working classes. Secondly, an excellent system of technical education was established which in course of time provided a large body of skilled experts, to whose researches, inventions and commercial developments a large part of the tremendous increase of industrial activity was due; and finally a flexible and adaptable financial system, which comprised a system of savings banks, land banks, deposit banks, and finally large trade banks, generally in close relation to the deposit banks, and each specialising in separate spheres of industry, encouraged and stimulated the trade development to such a degree that in less than half a century our supremacy in commerce was seriously challenged and preparations were being made to undermine our financial position.

This competition had been immeasurably assisted by, firstly, an apathy largely engendered by reason of long-continued successful trading, a high and luxurious standard of living, the greater cost of labour, an insular conservatism which was unable to adapt itself to, or take advantage of, the varying conditions and demands of trade, and by the fact that the financial and industrial sides of commerce were administered to a large extent from separate points of view, instead of in conjunction one with the other. The consequence was that on the outbreak of war it was found that the difficulty of obtaining supplies was immense, owing to the fact that practically all the "key" industries were controlled by our enemies, and so thoroughly had this been done that it was immediately necessary to institute a large system of Government control, so that these industries might be resuscitated.

As time went on, and the depth and nature of the influence on trade of our competitors was seen in its full significance, strong public opinion forced the Government to appoint a Committee to consider the whole question, and to indicate the best means of meeting the needs of British firms after the war as regards financial facilities for trade, and more particularly with reference to the financing of large overseas contracts. This Committee found that there was ample room for an institution which would be able to assist British interests "in a manner that is not possible under existing conditions, while not unduly interfering with the ordinary business done by the British joint stock banks and the other existing financial institutions," especially emphasising that German banks in particular seemed to have been able to afford special assistance at the inception of undertakings of the most varied description, and to have laid themselves out for stimulating their promotion, and for carrying them through to a successful completion, to the great advantage of the commerce of their country.

This report was issued on August 31, 1916, and so impressed were the majority of the members of the Committee with the importance of carrying the matter through without delay that on a petition of Lord Faringdon, chairman of the Committee, and four other members, together with two gentlemen of great commercial standing, a Royal Charter of Incorporation was granted on April 21, 1917, establishing a new institution on the lines suggested in the report under the name of the "British Trade Corporation," and conferring the fullest powers, together with a large measure of Government support.

The question of title had been very carefully considered, for it was felt that if the original one of British Trade Bank were used, owing to the limitations of usage in England of the word "bank" the majority of the transactions proposed to be undertaken by the new institution would not appear to be within its province, and although the wider foreign interpretation of the term "bank" would more adequately define its status, yet "corporation" obviously carried a fuller meaning to business men. The wide powers conferred under the charter, and the large measure of Government support indicated in its provisions, generated great opposition to its establishment, which was greatly encouraged by the Colonial banks, accepting houses, issuing houses, and bill discounters, who feared that a great and powerful rival was to be set up; but this was very largely overcome by the issue of a further declaration by the Corporation which strictly and distinctly defined its objects, limiting these to the fundamental purpose for which it was created, *i.e.*, to the giving of financial assistance to British traders and manufacturers, especially in connection with overseas trade, and stating that the Corporation was not intended to be, nor would it operate as, a competing contractor, merchant or trader.

Again, it was recognised that ever-increasing numbers of English traders had been taking advantage of the facilities foreign banks in London had afforded them, and that the closing of the enemy banks and the slight prospect of their reopening would create great hardship.

A large part of the opposition to the proposal was thus met and sanction was given by the Treasury for the issue of the £1,000,000 capital, which the charter strictly stipulated should be subscribed before the Corporation could commence business. This amount of capital was practically assured before the charter was granted and has been now all subscribed, and a prospectus has been issued inviting the subscription of the public to a further £1,500,000, thus making the amount equal to that recommended by the Committee as being in their opinion sufficient to commence operations on a sufficiently important scale.

It is, of course, familiar knowledge that most of the banks now existing in this country can trace their foundation to an association with some trade or industry, although the tendency of modern banking has been to keep itself aloof from actual participation in commerce, and to this attitude is

due in a large measure that want of appreciation which is so loudly bewailed by the trading community at the present time. Our competitors saw clearly that if closer and more intimate relations could be established between finance and commerce, it would be highly advantageous for all parties. To this end, therefore, their large trade banks were established, and every measure was taken to make the relations between the banks and industries more intimate. With this object, certain industries were allocated or chosen as a field for the operation of one particular bank, *e.g.*, one bank would finance the iron and steel industry, another the coal industry, another the electrical industry, &c., and in this way a profound knowledge was obtained of the fluctuations and requirements of the industry. This knowledge was developed by promoting companies, forming syndicates, and spreading the directorate of the bank among these companies and syndicates until the board of directors of the bank were able easily to ascertain from their own intimate knowledge where their assistance would be of the greatest mutual advantage and what further developments could be profitably made. Again, it was recognised that to develop an industry to its best advantage research work was vital, and by using their influence to obtain the best technical services available, processes of manufacture were cheapened and new inventions encouraged. When these were proved to be commercially profitable, financial support was given in order to establish them.

Again, while powerfully encouraging production, the question of marketing the product was also very carefully studied. Foreign markets and conditions were examined, special travellers were sent to discover the peculiarities of each market, trade catalogues were supplied in the language of the country, priced in the established currency, and terms of credit were suited to the accepted customs of the country. At the same time the questions of supplies of raw material were carefully studied; if necessary, syndicates were formed to ensure as far as possible a cheap and continuous supply, and, if required, means of transport were established to assist in this object. It will readily be appreciated that the weight and financial standing of the banks concerned ensured that the best terms possible should be obtained in these transactions, and economical measures were thus enabled to be taken which effected large savings and greatly cheapened costs of production.

Such are the particular fields which the proposed new Corporation is especially to develop, and it is in these fields that our present financial system has been most lacking, by reason of the fact that the working capital of our banks, *i.e.*, their deposits, is generally repayable at a moment's notice, necessitating its employment in easily marketable securities, and precluding its use in those transactions, which, naturally, demand advances for a much longer time, sometimes even extending into years, for their fruition.

Here, then, are illimitable possibilities in which the new institution is, as far as this country is concerned, a pioneer, but there will be room for many other similar corporations, and if they are properly carried on the commerce and industries of this country will be stimulated and developed, as were those of our competitors in the past. Further, the tide of prosperity will greatly benefit our present financial institutions, not injure them.

It must be borne in mind that at the end of the war there will be great financial exhaustion, while there will be an enormous demand for capital for reconstruction of the damage done to the conquered countries, to say nothing of that necessary to restart our ordinary commercial life. Moreover there will be heavy taxation to pay to meet the interest on the loans floated to enable the war to be carried on. When this has been accomplished there will be an enormous field of activity in the development of our colonies and the resources of the Empire, the possibilities of which have not yet been fully grasped. In meeting and fulfilling these conditions such institutions as the proposed new Corporation should, if properly organised and managed, prove of inestimable benefit, for they will save unnecessary expenditure, reform wasteful methods, and prevent overlapping of financial work.

THE FUTURE OF THE GERMAN IRON AND STEEL INDUSTRY.

THE export of iron in its various stages of manufacture played an important part in Germany's export trade before the war. During 1913 it amounted to 6,497,262 tons, which represented a value of some 1,340,000,000 marks out of an aggregate value of German exports of about 10,000,000,000 marks. The rapid growth of the German iron industry is illustrated by the fact that in the year 1900 its value only represented 479,000,000 marks, but in the year 1908 a value of 720,000,000 marks. It is consequently a problem of the greatest importance to the German manufacturers how the iron export trade will be situated after the war.

The statistical information which during the war has become known as to the production, civil and military, of the German iron industry, is looked upon as sufficient proof that the iron industry, the mainspring of an efficient export trade, has not only not lost ground, but, on the contrary, has increased its strength, both technically and financially. Its full capacity, of course, will only become evident after the war. The future export development, however, depends also upon the conditions of the world market. The constitution and ramifications of the world market are not quite so simple or so easily explained as many writers seem to believe. That market is a highly complicated congeries of large and small isolated or individual markets, and does not only consist of receiving or buying markets pure and simple, but also comprises intermediate trade markets, intermediate manufacturing markets, and what may be called auxiliary purchasing markets. All these markets cannot be treated by the exporter in the same way, for there are differences in the conditions of production, of transport, and of customs to be considered. Thus, for instance, entirely different conditions prevail in the matter of iron export to Spain and to Turkey or India, and the German export to England had to be worked in an entirely different manner from that to America.

In judging the capacity, as regards competition, in the complicated field which we call the world market, of the German iron industry, a distinction must be made between two different directions in the opportunities for export: the export to consuming countries, which have no, or in any case only an insignificant, production of their own, and which on account of adverse conditions (lack of necessary raw materials, shortness of labour, general inadaptability for creating an industry, &c.) cannot create such production; and, secondly, the export to countries which themselves boast a home production, but which before the war for various reasons imported iron products from Germany, so as to meet requirements which the home industry could not satisfy, or for the use of German half-finished goods in certain stages of manufacture or for subsequent export. In this connection Belgium and England may be especially mentioned—the former country imported considerable quantities of German pig-iron, whilst the latter took more advanced products, half-finished articles, bar iron, &c. Both countries found it profitable to cover some of their requirements of partly finished products from Germany, not for the purpose of finally using them within their own boundaries, but in order by their aid to produce goods for export. These countries naturally only chose this somewhat unusual mode of covering their requirements because it entailed certain industrial and financial advantages. Belgium is not rich in iron ore, and in order to procure the necessary foundation for her highly developed iron industry she ought really to have imported iron ore from abroad. Instead of this, Belgium chose to import, so to speak, purified ore, in the shape of pig-iron, from her close neighbour, Germany, having found that it was at least as equally advantageous as reducing the iron ore herself, which would also have entailed a material outlay and considerable additional labour. Also England's wealth of ore is insufficient in certain qualities for her requirements, and she found it answer her purpose, instead of pig-iron, to import half-finished products, bar iron, &c., that is, products in a more advanced stage of manufacture, so that more labour would be available for further handling and finishing of the goods, in preference to increasing her own, no longer fully adequate, steel industry.

This export from Germany, however, did not depend solely upon the difference in cost of production, but it was intentionally supported by the selling or dumping policy of the large German iron combines or unions for reasons which are well known to all. Against this policy voices were raised in Germany, even before the war, from various sides, on the plea that the home users of half-finished goods were less favourably positioned than the foreign consumers, which state of affairs naturally affected unfavourably the ability of the home manufacturers of finished goods to compete in the world market. The export premiums at times introduced in aid of the home manufacturers' export of finished products did not adequately counterbalance the drawbacks of this system.

In spite of all opposition the system of export sales at lower prices was steadily maintained before the war. After the war, however, new conditions will arise. The general industrial and commercial interests, which formerly could not prevail against the syndicates, are likely to be more powerful. The German iron industry has further developed during the war, and in consequence will not have such substantial residues of half-finished products as before. It has on several occasions been pointed out that that portion of the steel output which is worked up on the spot has increased during the war to a marked extent, at the expense of that portion which comes on the market for sale. In addition, it is realised in Germany that foreign demands for half-finished products will not exist to the same extent after as before the war, especially in Britain. Britain has materially expanded her steel production during the war. It is stated in Germany that her production of steel, which during 1913 amounted to 7,786,498 tons, rose in 1915 to 8,484,559 tons, and exceeded in the year 1916 9,000,000 tons. It is considered in Germany that this development is not cause for alarm. When, instead of feeding her finishing industry with cheap German half-finished products, England herself produces such goods at a greater cost, and when, on the other side, the German iron industry on an increased scale adopts the principle of producing finished goods in a rational and remunerative manner, instead of selling her half-finished products, on unfavourable terms, to her competitors, there will be a change in the international competition of the two countries on the world's market as regards the finished products of their iron industry, a change which, it is anticipated, should be in favour of the German iron export trade.

The United States of America was of no great importance as an importer of German iron products before the war. That country and Germany, apart from opposing tariff restrictions, were unable to enter upon any material competition in their respective areas. It was only on the world market that they met—there the German products had the advantage, owing to the system of combines and syndicates, of being offered at prices which at times were very near the actual cost of production, or even below, as long as the home prices offered any compensation. Such pushing of the foreign trade followed especially upon a quiet home demand. In America this differential handling of the home and the export business was not possible to the same extent.

During the war conditions have altered in America, as in Germany, through the enormous rise in the cost of production and of prices. Strangely enough, the rise of prices in the United States, which until quite recently had kept out of the war, was materially higher than in "blockaded" Germany. Thus in the United States the price of pig-iron, No. 2 Northern, since the beginning of the war, has risen from 15 dols. to 40 dols., and the price of bundle steel even from 19 dols. to 75 dols. The corresponding advance in the prices in Germany was materially smaller. As regards the world market, however, it is not so much a question of prices as of cost of manufacture. One must consequently guard against the conclusion that the

higher American selling prices mean that the cost of manufacture had also risen more in America than in Germany. In this connection it must be remembered that in Germany prices are under the control of the Government, whilst in America manufacturers had, up till recently, no reason to exercise moderation in view of the urgency of the Allies' demands. Nevertheless, the cost of production has increased materially in the United States during the war.

It is, however, impossible to arrive at an accurate or even an approximate result as to the relative proportion of the rise in cost of manufacture in the iron industries of the two countries during the war. Even if such statistical material were available it would not be of much use in this connection. It is of far greater importance to find out, if possible, how the cost of manufacture will develop in the two countries when peace is again established. In all the belligerent countries the cost of production will be increased by the interest on the war loans and by new taxes. Even assuming that part of this additional burden may be neutralised by technical improvements, a ton of pig-iron will not be produced at the same price after the war as was possible before, either in Germany or in England, in Belgium, in France or in Russia. The United States, too, has now joined in the war, and must face great expenditure, but it is a late comer, and has already accumulated immense sums by supplying munitions, so the burden will be easily borne. If, therefore, the war soon comes to an end, it is probable that a certain superiority in favour of the United States as regards cost of production of heavy steel goods will be the result.

After the war Germany, as compared with the United States, will have the advantage of lower wages, and this will tell specially in the manufacture of highly finished goods. In other words, the superiority of the Americans in the lower stages of production will disappear in the higher stages, and in the highest stages matters will even be reversed.

The German iron and steel industry has grasped the altered condition of affairs, and is already making new arrangements to meet it. It contemplates an immense reduction in the export of crude material, and is laying down plant for converting its iron and steel output into finished goods. Pig-iron girders and railway material will no longer figure so largely in the export list, and their places will be taken by higher-priced goods, with the result that more money will be available for wages and the balance of trade will be more favourable. The result is likely to be more satisfactory at home, but the great conveniences of dumping will be lost, a matter that will react advantageously on British manufacturers. It is to be hoped that peace will find us equally well prepared to push our trade in neutral markets.

AERONAUTICS OF THE FUTURE.

ALTHOUGH aeronautical engineers and others connected with the industry are at the present time engaged almost to the limit of their capacities on problems connected with naval and military aviation, it is nevertheless of the utmost importance that they should give very careful consideration to the production and utilisation of aircraft after the termination of the war. Unless some really workable scheme is ready to put into operation as soon as peace is declared, the cessation in the demands for war aircraft will force the existing manufacturing organisations and the great number of pilots, mechanics and other skilled workers to seek employment in other industries. The disadvantage of this is obvious when it is remembered that commercial aviation is bound to develop sooner or later, and that, apart from this, it is essential to keep an aircraft industry in being for use in some future war. Quite recently* we dealt with a lecture by Mr. Holt Thomas in which he showed that mail and passenger-carrying services might be inaugurated with every prospect of eventual success if given financial assistance by the State in the initial stages. The details of this, and other similar schemes for the employment of aircraft in normal times, have still to be decided upon by aeronautical engineers, financiers and statesmen, and the settlement of the many and varied problems involved will require a rather higher degree of foresight than is necessary for an ordinary commercial proposition; certainly more than was generally met with in this country during the early days of aeronautics. No doubt many of the problems will, in any case, solve themselves by the usual process of trial and error, but this slow, risky and costly process should be relied upon as little as possible, since early mistakes give rise to prejudices which are extremely difficult to eradicate and do much to hamper progress.

The fifth Wilbur Wright Memorial Lecture, which was delivered to the members of the Aeronautical Society on the 13th inst., by Lieutenant-Colonel Mervyn O'Gorman, C.B., dealt, in a very able manner, with the necessity for foresight in the aircraft industry, and directed attention to several matters which must be carefully considered in connection with aerial transport schemes. Such schemes are necessary to keep our aircraft factories as fully employed as possible, and to ensure an adequate supply of pilots and mechanics in the event of a future war. The national importance of maintaining extensive facilities for aircraft manufacture will be easily understood when it is mentioned that, according to Colonel O'Gorman, an aerial fleet requires complete renewal about six or eight times per annum during war. It is thus fairly obvious that the peace requirements of our own Army and Navy, and the orders we are likely to receive from foreign Powers, would be insufficient to keep many large aircraft factories fully employed. Neither would this class of work produce the large reserve of pilots, mechanics, and other skilled workers which should be held in readiness for employment immediately on the outbreak of war. In the matter of future construction for foreign Governments we are glad to associate ourselves with Colonel O'Gorman's censure of the critics who constantly boom German aircraft and decry that of British manufacture. If persisted in, this attitude, which arises solely from ignorance, is likely to have a deleterious effect on our aircraft industry when competing for foreign orders, and should be discouraged for this reason, as well as for the effect it may have on our airmen at the front.

Enough has already been said to show that aerial transport is of considerable importance from a national standpoint. Its claim to consideration from a commercial point of view is based almost entirely on the high speed obtainable in comparison with existing methods of transport, which advantage will more than compensate for its increased cost. It is obvious that the greatest amount of time-saving will be effected in long-distance journeys over seas, since marine transport is slower than land transport, and also because the inevitable loss of time at terminals is of less relative importance in long journeys than in short ones; foresight in the preparation of working schemes should, however, reduce this loss to the minimum possible in all cases. Financial arrangements, selection of routes, purchase of land, housing arrangements for personnel, compilation of lists of pilots, &c., preparation of designs for new machines, modification of existing machines, and the arrangement of motor services from cities to starting-points, are all matters to which careful attention should be given now if aerial transport services are to be inaugurated at the termination of the war.

It is generally admitted that some form of State aid will be required, at least at first, and Mr. Holt Thomas has suggested the subvention of mail and passenger services. There are, however, other ways in which the State may be called upon to assist private enterprise. One of these, referred to by Colonel O'Gorman, is the granting of limited inter-State monopolies, which will be necessary to avoid destructive competition until the schemes are well established. The State might also bear part of the cost of maintaining landing grounds, especially if accommodation for service pilots were always available. It is evident that if aerial transit is to be developed to any useful extent the question of flying over and landing in foreign countries will have to be considered at its inception. We should naturally desire foreign countries to be equipped with lines of landing grounds and aerodromes where necessary, and for this purpose it will be necessary to create abroad a body of opinion favourable to aerial transport. One way of effecting this, Colonel O'Gorman suggests, would be to establish industrial links between British and foreign aircraft constructors. These matters might also be fostered by entering into relations with foreign societies devoted to aeronautics on both the technical and commercial sides, although such societies, at present, are not so active abroad as at home. They might, however, be encouraged officially, and especially by our industrially linked firms. It follows, of course, that if we acquire landing rights in foreign countries it will be impossible to exclude foreign aircraft from this country, and, in Colonel O'Gorman's opinion, our best interests would be served by levying the smallest possible landing tax, provided that a reasonable degree of reciprocity is secured.

The matter of smuggling is a difficult question in connection with international flying. There seems to be nothing to prevent packages of dutiable goods from being dropped at night at prearranged points from aeroplanes which need not alight. It would be undesirable to insist on all incoming aircraft passing through some agreed port of entry for the purpose of Customs inspection. Such a condition would diminish speed—one of the most important desiderata of aerial transport—and might also prevent pilots from taking full advantage of favourable winds. Colonel O'Gorman's remedy for this difficulty is to admit all airborne goods free of duty, and to regard any advantage that might be derived from this arrangement by the aerial transport companies as a form of subsidy. The plan certainly has the merit of extreme simplicity, and might perhaps be tried at first, as far as this country is concerned, where the number of dutiable articles is not large and the duty charged is generally less than in other countries; here the cost of collecting the duty might easily exceed the amount collected. Smuggling would only be profitable in the case of light and valuable goods on which a high rate of duty is charged, as in other cases the extra cost of transport by aeroplane would exceed the duty charged. The whole question of Customs arrangements appears to us to be the one upon which the greatest opposition to international flying is likely to be based, and, for this reason, it will require an exceptional amount of forethought. Some of the difficulties, however, are more apparent than real, and doubtless solutions will be found which will avoid serious loss of revenue by the countries concerned without hampering the progress of aerial transport.

Among the many other matters to be considered Colonel O'Gorman mentions arrangements for night flying and landing, wireless communication between aeroplanes and the ground, preparation of flying rules, and education of personnel, as well as questions of labour, production, insurance, international law, &c. To settle all these points satisfactorily before the termination of the war, even if the latter is continued in accordance with the prophecies of our most confirmed pessimists, appears to be an almost hopeless task. They are, however, being dealt with by an Air Board Committee under the chairmanship of Lord Northcliffe, and by the Aerial Transport Committee; doubtless such energetic institutions as the Aeronautical Society and the Society of British Aircraft Constructors will also be of very material assistance in the work. If these bodies are able to arrive at acceptable conclusions on the more important points, so that the matter can be taken up in earnest when peace is concluded, they will have earned the thanks of the nation, as well as that of the aircraft industry.

FRENCH INLAND WATERWAYS.

UNDER the influence of transport difficulties due to war requirements many people in various countries, and particularly in Great Britain, are agitating in favour of the plea that canals are the means which, both in ordinary times and in times of special stress, can effectively solve the traffic problem and avoid the congestion which very generally obtains. A campaign on this question has been proceeding in England for some time past; a similar one has been in existence

* See page 548 *ante*.

for a long time in France, where there exists an important canal system—it is, in fact, this latter circumstance which has made it possible for unbiased observers to ascertain the very serious deficiencies which surround transport by canals, notwithstanding its apparent low cost. The failings which characterise transport by canals, and by canalised rivers, have always been clearly apparent in instances where exceptional conditions are not prevalent, A country like Germany, for example, sufficiently flat and level over extensive tracts to minimise first cost and cost of maintenance, and so fortunate as to own rivers like the Rhine, enjoys the exceptional conditions we refer to, and cannot be taken as an example to follow everywhere in the matter of inland water transport. The theory to the effect that canals are the best means available for the transport of heavy and bulky material, comparatively low in value, such as coal, for instance, was exploded many years ago by the French expert Arnollet, who showed that it was a great mistake to consider railways as suitable mainly for the carriage of passengers and of goods of comparatively high value. When an artificial competition is set up with a railway system by means of canals on which the goods carried pay an infinitesimal portion of the outlay incurred in the canal system, the State bearing practically the whole of the expenses, as is the case in France, one of the resulting evils is that the traffic which otherwise would be available for the railways is diverted from them and they are compelled to maintain their tariffs at a high figure and to postpone developments.

From the historical point of view, and very briefly, we may state that a considerable movement was started in France in 1820 for establishing a system of inland waterways to make up for the very imperfect means of transport by ordinary roads, the only means which were available at that early date. By the year 1845 a number of canals had been built by private companies, who, and very naturally so, charged for the right of using them. In 1879 an extensive programme of public works was set on foot, including a scheme of free internal navigation. The scheme was carried, and from that year it involved the setting up of a most artificial situation, one which completely prevented the economic conditions of competition between the inland waterways and the railways of the country. It is very easy to see how the former can give the illusion of being a most economical means of traffic; those who utilise them contribute practically nothing to first cost and maintenance charges. If railways worked on similar lines the result can easily be imagined. The cost alone of keeping the canals fully supplied with water to make up for losses from a number of causes is considerable in itself.

Since 1879 a total sum of 900,000,000 francs (36,000,000*l.*) has been spent on the establishment of French waterways. A canal of the section decided upon at that date has frequently cost 400,000 francs per kilometre (25,800*l.* per mile) to build, and when difficulties have had to be overcome the cost has risen to 700,000 francs (45,000*l.* per mile). On an average, therefore, the cost may be considered as approximately equal to that of a double-track railway, and in this connection it should be remembered that, between two given termini, a canal is much longer than a railway track, the difference in length being frequently from 15 per cent. to 20 per cent, and occasionally as much as from 50 to 60 per cent. These points, although they are of primary importance, are frequently unknown, even in France. It is not surprising, therefore, that in other countries where there are comparatively few canals much enthusiasm prevails in regard to them, the reason for this being that the public is but little conversant with canals from the standpoints of construction, operation and real efficiency.

At the present time, and owing to the congestion on the railways, due almost entirely to the war, an extension of the canal system is being mooted afresh in France; ambitious plans are being put forward, but the question of cost of construction and maintenance, and the experience gained in regard to the shortcomings of the existing canal system, appear to be ignored completely. Taken as a whole, the traffic on the French inland waterways, it is true, shows a high total and points to an increase from the early 'eighties of last century down to the present time, following the normal increase in all transport and in general business, and owing also to the fact that the traffic by canals and inland waterways pays no tolls. The increase, however, occurs exclusively on the main water lines, where the depth of water is a minimum of 2 m. (6 ft. 6 in.) and where the locks are 38.50 m. (126 ft.) in total length, with a width of 5.20 m. (17 ft.). These main water lines have a total developed length of some 6,000 km. (3,700 miles), and they have carried 90 per cent. of the total goods shipped by water and 97 per cent. of the total kilometric traffic. With reference to what we may term the secondary waterways, their total developed length is about 5,300 km. (3,280 miles), and their condition in regard to width, depth, and so forth are much less advantageous; they are used principally for local traffic.

As a rule the means of transport on the French waterways are of a primitive nature; they can hardly be otherwise, owing to the slow speed at which the craft are compelled to travel. There are a few steam-driven cargo boats, but in the course of one year they hardly transport more than 500,000 tons, and they mostly ply on rivers and canals where the conditions are exceptionally favourable, such as the Seine, the Havre-Tancarville canal, the Saône, Rhône and Garonne. The French inland water transport is mainly in the hands of small owners, to the number of about 8,000, of whom 6,250 own one boat only; 1,000 own two boats, and 540 from three to 10 boats. The total carrying capacity of these boats is 2,700,000 tons. The companies owning a fleet of boats are very few in number, as will appear from the above figures. The number of small owners is an interesting feature of the service; but their work is arduous and constant, and its remuneration is not high. They live on their boats with their families, forming a population of about 45,000 souls. It cannot be said that the single boat owner, who frequently can only depend upon the aid which his wife can give him in handling his boat, constitutes, together with his compeers, an economic factor tending to the enrichment of the country. As far as he is personally concerned he has no complaint to make against the slowness with which his boat travels, the time taken in loading it, and the long stoppages which he frequently has to put up with, due to congestion on the canal. He simply carries out an industrial pursuit without reckoning with the expenditure of time. He further takes little account of a sinking fund, but considers as a wage, which he may immediately make use of, any sum he may receive for his transport work, and he is generally in a bad way when his boat is worn out and has to be replaced by a new one. When that time arrives he has practically no capital at his disposal. If the tolls had not been done away with in 1880, and if measures had not been repeatedly enacted preventing the railway companies from lowering their tariffs when they were able to do so, on the plea that lower railway tariffs would result in a competition detrimental to inland navigation, the single boat owners would have disappeared long ago. As will be seen, therefore, the situation is an entirely artificial one, as above-stated. It should be added, moreover, that inland navigation has to sustain periods of stagnation which very frequently coincide with periods of active business which otherwise would create a demand for boat traffic. Further, every three years the canals are emptied for maintenance and repair work, and when this is completed the return to normal conditions of traffic often takes a long time.

It is fully evident that a navigable waterway such as the Seine from Paris to Rouen and Havre is most serviceable, and one that has proved most useful in the course of the present war, but its establishment, maintenance and improvement have involved an enormous outlay, notwithstanding that in this particular case it was a natural waterway which was being utilised. The current outlays for improving and extending the waterways which now form the inland navigation system of France have amounted to an annual average of 15,000,000 francs (600,000*l.*) per year from 1887 to 1907. Since the latter year they have been notably on the increase, following upon a new programme, and since 1911 they have reached annually about 27,000,000 francs (1,080,000*l.*). And these outlays on the waterways are borne by the taxpayers of the country; in this respect a portion of the taxes paid by every citizen constitutes a gift made by them to those who utilise the inland navigation system.

The canal boats are still frequently hauled by man-power or by a horse; electric traction, which has been tried on several parts of the system, has given but poor results. A better organising of the working of the canal traffic might perhaps prevent exceptional delays and congestions, but would not increase the speed, owing to the conditions under which the canals have been built. In France, therefore, owing to the unevenness of the ground, inland navigation, even were new and improved canals to be built, would probably remain a means of traffic too imperfect to be able to bear an appreciable portion of the cost of construction and of maintenance. The charges will continue to fall upon the general public, whilst they should logically be included in the freight account.

The relative importance of the transport by railway and by canal is easy to ascertain as regards, among others, the northern region of France, where the principal inland waterways are located, and where the railway is able to insure in good condition the carriage of coal from the northern coal basin to Paris. One night is generally sufficient for the delivery by rail of 900 tons of coal to Paris from a northern colliery. In the region mentioned the railways transport 75 per cent. of the total coal which proceeds both from the French collieries and from imports into France; the waterways carry the remaining 25 per cent. in 300-ton barges, and if they were so advantageous as they are stated to be, it is evident that the conditions would be the reverse. It may even be said that the proportion which falls to the railways is on the increase, the boats taking only about 19 per cent. to 20 per cent. of the increase in the quantities dealt with following upon improved industrial conditions. The cost of transport from Lens to Paris by canal is about 5.70 francs (4*s.* 7*d.*) per ton; this is the sum paid to the boat owner, and it takes, as we have seen, no account of interest on the canal outlay, sinking fund, maintenance of the canals, &c. By rail the cost of carrying coal from Lens to Paris was, before the war, 6.70 francs (5*s.* 4*d.*) per ton under ordinary conditions. Large reductions are made when, for example, the deliveries are by trains of twelve 20-ton wagons, or, again, when heavier wagons still are used and supplied by the colliery or the purchaser, when the cost of transport per ton falls to 5.40 francs (4*s.* 4*d.*) and even to 5.14 francs (4*s.* 2*d.*) per ton for a train of sixteen 40-ton wagons which belong either to the colliery or to the purchaser. In comparing the two methods of transport the time taken, and its consequences from a pecuniary point of view, should not be lost sight of. Moreover, the long exposure to wet, heat or frost, of the coal carried by canal barge is also a feature which militates against the use of the waterways for the carriage of that commodity.

Therefore if a railway in France can carry more cheaply than a canal, notwithstanding all the pecuniary advantages which are granted to the latter, and can, moreover, do so in the case of heavy and bulky goods, for which the railway tariffs must of a necessity be comparatively low in order that the selling price of the goods at destination be not exorbitantly high, it is easy to see that a canal cannot compete in the instance of manufactured articles or perishable goods, for carrying which, it is true, the railway demands a higher rate, but where rapidity of delivery is an absolutely necessary condition to meet.

The French canal system will continue to be utilised to the largest possible degree, although every transport operation by canal, if every item be taken into account, means in reality a loss to the public. It is greatly desirable, says our French correspondent, who sends us the above information, that the system be no further extended and that no further outlays be made for transformations. The countries where railways render the services that they do, and where canals are scarce or have been partly abandoned owing to cost of

operation, would find it greatly to their disadvantage to return to a means of traffic which belongs to past generations, and is so thoroughly inferior to a railway worked rationally and embodying all the industrial improvements now available.

THE GERMAN IRON AND STEEL INSTITUTE.

On March 4 the Vereins Deutscher Eisenhüttenleute held its general meeting at Düsseldorf, and the report of the proceedings makes very interesting reading. Sir Robert Hadfield has done a service to the iron and steel makers of this country by preparing and publishing a translation of the speeches, which seem to have been made without any fear of the censor. We have not space to deal with more than a few points. The membership of the Institute increased during the year from 5,948 to 6,052. During the same period 76 members died, of whom 24 fell in the war, increasing to 105 the numbers who had lost their lives in this way. It is clear that the members of the Institute are mostly employed at home, otherwise the fatalities in two and a half years must have been greater. On the other hand, one member has been awarded the *Order pour le mérite*, 41 members hold both the second and first classes of the Iron Cross, 320 the second class only, and 66 other orders. This makes a total of 469 decorations.

Quite a number of commissions and committees are sitting. These include: (1) the blast-Furnace Commission, (2) the Department for the Investigation of Bad Results obtained in the Use of Blast-Furnace Slag, (3) the Rolling Mills Commission, (4) the Coking Commission, (5) the Chemists' Commission, (6) the Iron Sleepers Commission, (7) the Commission for Studying the Question of the Grooving of Rails, (8) the Technical Commission of the Association of Thick Iron-Plate Rolling Mills, and (9) the Legal Commission. All these commissions have made some progress, but in certain cases the war has greatly hampered their efforts. The board are asking for contributions to a fund for an "Institution for Metallurgical Research," which is to be the war memorial of the German iron industry, and to deal with the large number of new problems which have become acute of late, such as the desulphurisation of blast-furnace coke, the elimination from ores of their water of crystallisation, the development of the mixer, the desulphurisation of and elimination of manganese from Thomas slag, and the better utilisation of the waste products of metallurgical working in general, and many other matters.

The meeting was followed by a dinner, at which the president, Dr. Fr. Springorum, who in 1914 was a member of council of the British Iron and Steel Institute, said that nothing could have strengthened their unanimous determination to hold out more than the anxiously-awaited order of His Majesty the Emperor by which unrestricted liberty of action was given to the commanders of the U-boats. Mr. Paul Reusch, also a former member of our Iron and Steel Institute, said they would do their duty in order to bring down their greatest enemy, England, who had to be brought down if the war was to be won. Lieut.-General Groener said that the hostility of England was attributable to the achievements of the German iron industry in peace time, because England found herself beaten in the domain of the iron industry. The intellectual authors of the war were in London. Dr. Beumer confidently hoped still for a war indemnity, which enemies would have to pay to Germany in cash. He felt great anxiety on account of certain tendencies which aimed at a transformation of the economic system of privately controlled enterprise into one of publicly or collectively controlled enterprise. They were drifting towards a stage of over-organisation. "One new office after another was being created, one organisation was treading on the heels of another, the number of advisers and commissions was legion; in fact, in order to staff all these organisations one had no longer sufficient men who knew anything of the matter in question, and it could serve no useful purpose to appoint men without knowledge of the subject. At the same time the 'watertight compartment' attitude of the official was playing an ominous rôle in this respect, as to which Bismarck had said that a regular 'departmental patriot' was always looking upon any other department as 'foreign country.' A supervening circumstance was that each newly-created office commenced with 'inquiries,' notwithstanding the fact that similar 'inquiries' had already been instituted by existing departments, the result of which had been quietly shelved by these." If anything could ever reconcile us to the Germans it would be revelations of this sort. "A fellow-feeling makes us wondrous kind."

THE NATIONAL PHYSICAL LABORATORY IN 1916–17.

(*Continued from page* 599.)

Road Board Laboratory. Rubber Tyres. (Mr. R. G. C. Batson.)—The mechanical tests of road materials have dealt with 12 varieties of stone, especially for military roads. A new subject, taken up by the request of the Road and Tyre Wear Committee of the Society of Motor Manufacturers and Traders, is the endurance of rubber tyres. The new tyre-testing machine designed is not yet ready for use.

The total number of tests made by the Engineering Department was 980, against 640 and 617 in the two preceding years.

The William Froude National Tank. (Superintendent, Mr. G. S. Baker, late R.C.N.C., M.Inst.N.A.; Messrs. J. L. Kent and G. H. Bottomley, Miss E. M. Keary; Lieutenant G. H. Millar, Captain W. J. O. Shedd and two others are on active service.)—The report of the Advisory Committee is highly satisfactory from the national standpoint, and in consideration of this fact also from the economical standpoint. The number of experimental runs with the carriage exceeds that of any previous year by 30 per cent., but research had practically to be suspended, owing to the absence of senior members of the staff, though the total staff has been increased and has had to do overtime almost throughout the year. Mr. Baker was awarded the Shipbuilding Gold Medal of the North-East Coast Institution of Engineers and Shipbuilders for his "Notes on Model Experiments" of November, 1915.

No tests of the rail-level have been made during the past two years; the speed remains fairly steady, but the long overdue checks of the rail-level and also of the driving gear of the carriage cannot be postponed much longer, especially as the prolonged cold weather was a severe test of the tank walls and rails. Even during the time when the air temperature remained below freezing-point for several days consecutively it was possible to keep the tank water temperature at 45 deg. F.; the water was not replenished during the cold February. There has not been any progress with the small tank or with the screw-testing apparatus. The tests of full-size seaplanes have also been discontinued; but Miss Keary and Mr. Bottomley have done excellent work with seaplane models for the Advisory Committee for Aeronautics. An apparatus for the generation of series of regular waves has been constructed.

The number of models tested for firms, from first-class liners down to cargo tramps, was 26 in the year 1916 and 57 for the year 1916–17, against 18 and 61 in the two preceding years. The best result obtained was a reduction of 7 per cent. in resistance without variation of displacement or dimensions. For a vessel of exceptional type the reduction of resistance has exceeded these limits by a considerable amount. The experiments generally aim at determining the best form or the power required for a fixed displacement of a given form; the value of these tests would be considerably increased if experiments were made at different draughts for the same form, and the additional work, it is pointed out, would not be very great.

In the investigations for the Admiralty and other authorities the assistance of Lieutenant Powell has been very valuable. The only research model tested was run merely to clear up certain points as to the resistance of slow-speed vessels. The investigation of skin friction has made little progress. Some of Colonel Beaufoy's experiments have been analysed in the same way as those of Froude, Geber and Zahm were analysed last year; on the whole, the agreement with the mean curve adopted for the planks of Froude and the National Tank is very fair. But the 13-ft. and 16-ft. submerged logs of Beaufoy gave decidedly higher results; these logs had a rather full taper, and the discrepancy is ascribed to end-effect correction. The results obtained by Tideman at the Rijks Wharf, Amsterdam, are to be analysed in the same way. Some of these features were dealt with by Mr. Baker before the spring meeting of the Institution of Naval Architects in 1916. The committee conclude by expressing their regret that research work, which, they are sure, will be much more required in the future, should have been crowded out, and they trust that the increased expenditure involved will not stand in the way of research.

Physics Department. Electricity. Fundamental Units. (Mr. F. E. Smith and Mr. H. C. Napier.)—The work of this division has been almost entirely confidential and has more especially been connected with radiotelegraphy. Amplifiers for intensifying the sound intensity and the heterodyne apparatus for producing continuous currents and for rectifying and transmitting waves with the aid of valves (with three electrodes) have been tested by new methods, which, it is hoped, will be published in the future. The compass work is also largely confidential; a declinometer of the Laboratory type has been erected at Woolwich, and assistance has been given to the R.E. Stores at Woolwich in improving the testing methods. On the other hand, military prismatic compasses and ships' compasses have been investigated with the object of affording help to the manufacturers in improving their methods and in reducing the cost of manufacture. The indispensable checking of electrical standards and of normal Weston cells has been continued. The disturbances, especially of the magnetic investigations, due to the electrification of the London and South-Western Railway have become so serious that the matter has been referred to arbitration, in accordance with the precautions taken by H.M. Office of Works for the protection of the Laboratory work. The act provided that the magnetic disturbances should not exceed those observed in the magnetic hut of the Laboratory previous to the electrification by more than 20 per cent.; but the 24-hour magnetograph records taken show disturbances largely in excess of those permitted.

General Electric Measurements. (Messrs. A. Campbell and D. W. Dye.)—The tests made in this division of condensers, magnetic properties, standard cells, resistances, frequency and wave meters, &c., have risen to 203, against 140 and 191 in the two preceding years; these figures, like those previously given, do not include special testing for the Ministry of Munitions, we should add. More time has, however, been taken up by confidential work.

Self-inductance of Small Resistances. Telephone Frequencies. Magnetic Researches.—The self-inductance of shunts of low resistance (alternating current) should be very small, and by appropriate compensation the self-inductance can generally be reduced to zero or even to a negative value; a good shunt of 0.001 ohm would have a self-inductance of a few thousandths of a microhenry, and the time constants to be dealt with would not exceed 10 micro-seconds. The measurements of these inductances offer no particular difficulties for resistances of two terminals, but for shunts with potential terminals (four-terminal resistances) simple methods had to be devised. Mr. Campbell hopes to describe these methods in the Physical Society. The question affects especially large meters, which have given trouble in America, for instance. Frequency determinations can in the simplest cases be made with the aid of a tachometer, of course, if average values be sufficient. For higher frequencies the vibrating reeds of Hartmann are suitable. When telephone frequencies are exceeded Mr. Campbell makes use of his very simple small mutual inductometer: on a small board which encloses a condenser there is mounted a flat coil which is so pivoted that it can be turned by hand through a large arc; the scale is graduated directly in frequencies. The new wavemeter coils have been tested for effective resistance by the Bjerknes method. For generating currents of radio-frequency a pair of flat coils of low effective

resistance has been constructed of copper strip wound in open spiral form; the coils are mounted to slide on rails and can also be turned round a vertical axis in order to vary the coupling.

The magnet steel research for the Institution of Electrical Engineers concerns alloy steels (tungsten, chromium and molybdenum). The testing of horseshoe magnets for magnetos is difficult because the horseshoe, over which the coils are slipped, is not of uniform section, and the hole pierced in each limb near its end to fix the pole-piece further disturbs the uniformity, which the bending and chilling of the bar, moreover, impair. Thus the magnetic hardness varies from point to point. In testing these horseshoes, the pierced ends are disregarded, and two coils wound flat on a strip of cardboard are bent to the arch shape of the shoe, one inside and one outside. The high magnetisation of armature teeth calls for special methods of testing. The ordinary isthmus method, suitable for rods or bundles of rods, which are placed axially in the coils inserted in the pole gap so as to form an isthmus, is not convenient for this purpose. The pole-pieces are now provided with a vertical slot which can receive a number of narrow strips making up a bundle of a square section of 5 mm. The differential search coils are a pair of flat coils applied to opposite faces of the bundle. Values of H up to 3,000 can be measured in this way, and up to H = 2,000 the results obtained are in exact agreement with tests made on long strips of the same material placed in an open solenoid.

Electrotechnics, General Work, Photometry. (Messrs. C. C. Paterson, E. H. Rayner, A. Kinnes, B. P. Dudding, J. W. T. Walsh.)—Both Mr. Rayner and Mr. Dudding being occupied elsewhere, Mr. W. E. Higgins and also Dr. Norman Campbell (volunteer) assisted in this division, where overtime has been worked throughout the year. Mr. Kinnes practically had charge of the test work. The important confidential work comprises the development of a novel type of apparatus, due to Messrs. Paterson and Walsh, for use in connection with anti-aircraft gunnery; the work entailed the initiation of the early experiments, the development of the practical form of apparatus in conjunction with the manufacturers, demonstrations and lectures to officers, preparation of a handbook, and a visit to the front in France for demonstration purposes. There have also been researches on the visibility and detection of distant objects, and on the reflecting power of mirrors. In investigating magnetos for aircraft and in determining their crest voltage, use is made of an old Kelvin balance of the Laboratory, which had hardly been put to any use so far. The voltage of these magnetos suddenly rises to a maximum of 20,000 volts, and this crest value is alone to be determined; the balance is connected with an ionic valve rectifier. Investigations have been made in regard to insulation for special purposes and to wireless generators, and a cathode-ray oscillograph has been constructed, on the lines of the Braun instrument. Both the Service requirements and the large industrial development entailed in the production of munitions have involved much testing and standardisation. The total number of general tests, 7,771, was smaller than in 1916, but this number excludes photometry work (15,258 tests, five times as many as in 1915) and work for the Ministry of Munitions, and the tests of radium luminous compounds for gun-sights and aircraft instrument dials alone concerned more than 10,000 dials.

Radium Luminous Compounds.—This testing is now carried out for both the Services, and the method, which is standardised, and the researches were quite recently described by Messrs. Paterson, Walsh and Higgins before the Physical Society.* We noticed the method in our account of the Optical Society's Exhibition of last December. The dial to be tested is placed between two metal stencils cut out so as to be an exact replica of the luminous markings of the dial under test; the screen behind the stencils is illuminated from behind by the light from a lamp passing through a colour filter; the value of the current in the lamp is a measure of the brightness of the dial markings. These markings of dials, which are painted with a compound containing 0.4 mg. of radium bromide per gramme of zinc sulphide, must have a luminosity of not less than 0.0075 equivalent foot-candles, and the ammeter readings are expressed as percentages of this value. There has been a great improvement in the number of rejections since the initiation of these tests, particularly for dials in which the markings are recessed, and not merely surface painted. The decay of the compound itself is peculiar. Observations for 15 months show that the rate of decay decreases slowly, and that whatever the initial Ra contents above 0.1 mg. per gramme of ZnS, the final luminosity will be the same provided the sulphide be the same. This is important for gun-sights, where the compound is used as a powder and not mixed with varnish, as it is in the case of the dials. The usual Ra content of the compound is 0.4 mg., as we mentioned. The luminosity goes down to about half its initial value in six months; and when articles are liable to be stored for a long time it will be useless to give the full Ra percentage, if after a year 0.2 mg. will be as effective as 0.4 mg. would be. The luminosity standard of the Laboratory for 0.4 mg. compound is 0.03 equivalent foot-candles, *i.e.*, four times that of the compound mixed with varnish. For the first three weeks after mixing the luminosity remains proportional to the radium percentage; but this does not hold subsequently; the limiting value for all compounds containing 0.2 mg. of RaBr is of the order of 0.01 equivalent foot-candles. The radium seems to deteriorate the varnish; it may also affect the zinc sulphide, and as the luminosity of the zinc sulphide itself, and its dependence upon impurities of the sulphide, is little understood, this sulphide ought to be further studied; that would be a task for the chemist in the first instance. In testing the compound a small glass tube containing the compound (value about 7*l.* per gramme) is placed in a small box and observed through a tube and a screen, the lamp on the photometer bench being brought up until the patch of glow and the illuminated field around it match.

We should also mention the integrating cube for measuring average spherical candle-power, which has been in use for several years; the suggestion is due to Dr. Sumpner. It is a small room rather than a box, and though the enclosure is not spherical, it will answer for practical measurements; the walls are painted a dull white with a non-selective compound; in one of the walls is a window, 3 in. square, outside which the photometer bench is mounted; the lamps to be tested are suspended within the box.

Continuous Current and Resistance Measurements. Buried Cable Research. (Mr. S. W. Melsom, Mr. H. C. Booth, Miss V. Cockburn.)—Testing for the Admiralty and the Munitions Inventions Department and private investigations of insulators have kept this division very busy, and though the work did not quite come up to last year's total, it was twice as large as in the highest pre-war year. The most important research about which information is given concerns the heating of buried cables, a subject taken up by request of the Institution of Electrical Engineers in continuation of Mr. Melsom's former cable work. Cases of breakdown of underground cables due to heating during the hot season are not infrequent, not only in America, but elsewhere, but the problem had hardly been studied systematically so far; the recent calculations of Matsumoto and also of German investigators were not based on sufficient experimental data, and observations in ducts seem only to have been made by R. C. Powell. The Privy Council Committee for Scientific and Industrial Research made a grant for this research, but work was delayed owing to want of labour. The cables are tested in lengths of 100 ft., and two huts with concrete foundations have been built and joined by a conduit along the Bushy Park front of the Laboratory grounds. The County of London Supply Company gave valuable help by lending the cables, as well as by drawing in and jointing the large concentric cable (0.5 sq. in.); the jointing and laying of the other cables was done by the Laboratory staff. The cables—all paper-insulated—were laid as follow:—(*a*) Armoured cables, laid direct in the ground, 0.1 sq. in. or 0.2 sq. in., concentric; (*b*) cables laid solid in bitumen, plain lead-sheathed in one trough, two cables, 0.1 sq. in., single, and two 0.1 sq. in., concentric; in another trough one cable 0.2 sq. in., single, and one 0.2 sq. in., concentric; (*c*) drawn into a six-way stoneware duct: cables 0.5 sq. in., 0.2 sq. in., 0.1 sq. in. (two lengths of this latter), all concentric. The Newcastle-upon-Tyne Electric Supply Company further lent five lengths of three-conductor cable, two of which were of sufficient length to be drawn into the six-way duct. While the construction of the concrete block ends and of the huts, which are sunk below the duct level and are neatly fitted up as small laboratories, and the laying of the duct, were in progress, the cables were laid on the Laboratory floor in order to determine their thermal and electric constants and their insulation; the insulating paper was also examined. Among other points dealt with is the influence of painting the lead sheath a dull black or white. Pending satisfactory arrangements for the supply of continuous current, the tests are made with alternating currents of 55 cycles, the resistance measurements—from which the heating of the inner and outer conductors and of the lead sheath are deduced—being effected by superposing a small continuous current (about 20 amperes on 800 amperes alternating) from three portable accumulators in parallel, which can be put in series withthe secondary of the transformer and the cable under test. The measuring galvanometer then responds only to the continuous current, the vibrations due to the alternating current being very slight, while the accumulators are apparently unaffected by the heavy alternating current. The galvanometers themselves are set on the concrete floor of the hut, and the light spots are brought up to the height convenient for observation by means of mirrors. In order to eliminate errors due to additional heating of the length of cable coming out of the ground, pilot wires are taken off all the cables laid direct in the ground or in bitumen at a distance of 5 ft. from the concrete end. This was impossible with the cables drawn into the duct because the joints took up too much space, and in their case the temperature gradient along the duct is being determined. It was hoped that a number of thermo-junctions pulled into the duct would give the required information. But there is a decided temperature gradient in a vertical cross-section of the duct itself, and the temperature of the junction would depend too much upon the more or less accidental and uncertain position of the junction in the duct; hence a supplemental cable with tapping points all along the duct length has been adopted. The cable lies at the bottom of the 3½-in. duct; the temperature rises highest in the inner conductor, less high in the outer conductor and in the lead sheath, and then diminishes in the air space between the lead and the top of the duct. The extensive observations are in charge of Miss Cockburn, who came to the Laboratory fresh from Cambridge. The very careful work has been favoured in a certain sense by the extreme temperatures of this year; ground temperatures are also taken regularly, and the report which is being drawn up may give some definite information on the influence which cold and hot weather have on buried cables. The temperature of the Gulf Stream, it will be remembered, was deduced from resistance observations on certain Atlantic cables.

The corrosion of the lead sheathing of cables for internal wiring is also being further investigated by request of the Institution of Electrical Engineers. Wet and dry plaster are the main media for internal wiring, and the bonding and earthing call for a study of further materials.

(To be continued.)

* See ENGINEERING, June 22, page 589 *ante*.

NOTE.

REFLECTION OF SCHUMANN RAYS BY METALS.

INVESTIGATIONS of the optical properties of metal generally have stopped short at λ 1850 Angström units. This wave-length constitutes a natural boundary in the spectrum, because the absorption of the rays by the air necessitates the use of a vacuum spectroscope and of Schumann plates for light of shorter wave-length. At λ 1250, then, a point is reached beyond which no light is transmitted by any solid substance, not even by the white fluor-spar which is used in Schumann-ray experiments. In the study of such rays the experimenter can hence

no longer rely on refraction, but must resort to reflection; but the reflective powers of mirrors for light of extremely short wave-length is unknown. Schumann himself and Mach tried magnalium (Mg-Al) alloys for rays down to λ 1850, and found that some of these alloys reflected ultra-violet light better than any other materials. None of the other experimenters have gone beyond λ 1850 by the direct method. Work done by the indirect method, first used by Voigt, in which the reflection coefficient is derived from a measurement of the constants of the elliptical polarisation produced when a beam of plane-polarised light is reflected from the substance in question, had not extended beyond the λ 1850 either. In his recent experiments with 28 substances, metals, carbon and carborundum, Hurlburt used the direct method again, measuring the intensity of light by means of a photo-electric cell. Working at Harvard University last year, I. C. Gardner has first penetrated into the hitherto unexplored range, and has studied the range λ 1600 to 1030. In his experiments (*Astrophysical Journal*, January, 1917) the light from an electric discharge tube, a quartz capillary of 0.6 cm. diameter fitted with aluminium electrodes, enters a vacuum spectroscope (generally filled with hydrogen at a pressure of 1.8 mm. of mercury), and the rays are thrown by a mirror on to a grating made of speculum metal; the hydrogen spectrum of crowded lines thus obtained is photographed on a Schumann plate. The mirror is made half of speculum metal and half of the substance under test; two spectra are hence obtained on the plate, and the measurments are comparative, speculum metal serving as reference substance. The ruled portion of the grating, which is curved to a radius of 102 cm., is 2.8 cm. by 5.3 cm.; the grating spectroscope resembles that of Lyman. Nine substances were examined by Gardner. Silicon, which had given excellent results to Hurlburt and to Nutting (reflection coefficient of 65 per cent. at λ 1850) proved indeed much the best reflector of any of the nine substances. The silicon specimens were obtained from the carborundum works in Niagara Falls, and sawn into slabs, which easily took a good polish by means of rouge on a beeswax lap; the silicon did not tarnish, and seemed to reflect between λ 1640 and 1300, about twice as well as speculum metal. The measurements were not quantitative, as we said, because of theoretical and technical difficulties; but the statement means that the spectrum reflected from silicon with two minutes' exposure was fully as strong as that from speculum metal with an exposure of four minutes. Gold mirrors, produced by cathode volatilisation, differed very little from speculum metal. This held also for mirrors of stellite, an alloy chiefly of chromium and cobalt of secret composition. Platinum, likewise deposited on glass by cathode volatilisation, proved superior to speculum metal for wave-lengths of less than λ 1300; this is interesting, as silicon, otherwise better, became a poorer reflector for the extremely short waves. Copper (also volatilised) was distinctly inferior to speculum metal, nickel about equal to it; but the production of mirrors by cathode volatilisation—a matter of 10 minutes in the case of gold, 30 minutes for platinum—took 3 hours in the case of nickel. Aluminium was very difficult to polish, and a poor reflector. Silver, easily polished, was decidedly inferior to speculum metal; steel mirrors, hardened and polished by Messrs. Alvan Clark and Sons, reflected better than speculum metal down to λ 1300, but not beyond. Gardner did not try magnalium; Hurlburt had not recommended it.

PERSONAL.—Mr. C. H. Ridsdale, F.I.C., F.C.S., &c., has now retired from the position which he held for over thirty-four years as metallurgical manager and chief chemist to the North-Eastern Steel Company, Limited, Middlesbrough, and has joined Messrs. Ridsdale and Co., metallurgical and consulting analysts, of the same town.—We have received the information from a private source that the Duma of the City of Baku (Caucasus), in its meeting of June 12, has unanimously decided to present the freedom of the city to Sir William Lindley, M.Inst.C.E., F.G.S., in recognition of his great and successful work in designing and carrying out their water supply. This work has been inaugurated quite recently, bringing the supply from a distance of about 112 miles from the mountains of the Caucasus.

SOCIETY OF GLASS TECHNOLOGY.

A JOINT meeting of the Faraday Society and the Society of Glass Technology was held in the Department of Applied Science at the University of Sheffield on Wednesday, June 20. Mr. W. F. J. Wood, B.Sc., was in the chair. Dr. William Ripper, vice-chancellor of the university, opened the meeting with a few words of welcome from the Applied Science Department.

Professor W. G. Fearnsides, M.A., followed with an address on "The Resources of Refractory Materials available for Glass Manufacture." The problem of refractories was, he said, common to both the steel and the glass industries. In the manufacture of steel furnaces were run at a much higher temperature than in the case of glass, and so, from the point of view of withstanding temperature, a refractory useful in steel would be quite good for glass. In the manufacture of the latter, however, the severest test on the refractory was its power of withstanding chemical action. Refractory substances were to be found in different geological formations, but it was worthy of note that many of the most-used refractories were in the vicinity of coal measures.

In the course of the lecture the occurrence and relative importance of various ganister and fireclay beds were discussed, and their positions indicated on a large scale map. The resources of refractories in the West Riding of Yorkshire received particular emphasis, special mention being made of silica from Meltham, near Huddersfield, ganister from the neighbourhood of Sheffield, and fireclay from the Halifax district. The relative values of the "wooden box" clay from Church Gresley in the Leicester coalfield, of the clay from South Wales, and from Glenboig in the south-west of Scotland, were also commented upon. An interesting and instructive address ended with a discussion of the kaolins and ball clays of Cornwall, Devon and Dorset.

Mention should be made of a very representative collection of specimens of refractories which had undergone change in glass and steel furnaces. At the close of the meeting these specimens were the subject of an animated discussion among members. It is hoped that several of them will be available for future reference in the museum of the society.

A second address on "Refractory Materials" was delivered by Mr. J. H. Davidson, M.Sc., of the Glass Technology Department of the University of Sheffield. The analyses of various clays were given and their likenesses and differences were discussed. In addition, a stone from Durham used in building glass tank furnaces had been analysed, together with several similar local stones. The stones differed little amongst themselves in analysis, but were widely different from clay, as they contained considerably more silica and less alumina. Some most valuable information regarding the plasticity of various clays was imparted. It was shown that the percentage of water taken up by a clay in working was a measure of its plasticity, and methods of testing the plasticity of clay were given. From the numbers obtained it was found that "wooden box" (Church Gresley) clay was anomalous in its behaviour. The Leeds fireclay required 18 per cent. of added water for plasticity, Halifax 18½ per cent., Stourbridge 18 per cent., German 19½ per cent., whilst "wooden box" required as much as 25 per cent.

The contraction due to drying and firing was next considered, and very useful data were given. Most clays contract 5 per cent. to 6 per cent. in drying, but "wooden box" is again unique, as it contracts 6½ per cent. The firing tests were carried out in two stages. First of all the shaped blocks were fired at a temperature of 1,000 deg. C., when a contraction in length of ½ per cent. to 1 per cent. was noted, with the exception of "wooden box," which contracted as much as 11½ per cent. Under the same firing conditions the stones increased about 1 per cent. in length. A second firing to 1,450 deg. C. was given, and the following total contractions were observed:—

	Per cent.
Halifax clay	8¾
German clay	10
Leeds clay	10
Stourbridge clay	11
"Wooden box"	17

At this temperature it was found that stones increased 3½ per cent. in length. In all the tests carried out it will be observed that "wooden box" clay is anomalous in its behaviour.

Since clays contract so much on firing the necessity for the admixture of "grog" in pot-making is at once apparent. In the opinion of the author the present-day pot-maker used too little "grog" and also "grog" of the wrong type. Instead of using ground broken pots, he advocated the use of fresh-burnt raw clay which, although requiring great care and some trouble in preparation, would be most efficacious.

Dr. Walter Rosenhain, D.Sc., F.R.S., then spoke, pointing out that the desiderata of a good refractory were: (1) non-fusibility, (2) resistance to chemical action, (3) facility of manufacture, (4) availability, (5) correct thermal conductivity. Unfortunately all these points could not be combined in one substance, and so no ideal refractory was on the market. Most glasses are "acid" fluxes, and so liable to attack basic materials in the refractory. Thus it is that clays with increasing alumina content are so resistant to glasses. One great obstacle in the glass trade was the time taken in building and drying pots, and he hoped that in the near future pots would be made by a casting process. Regarding "grog" in pot building, he was of the opinion that slate could be used as a binding material and to alleviate shrinkage, giving as it would a sharp-edged particle and also being very refractory. He also advocated the measuring of the plasticity of clay by means of the "penetrometer." Concluding his remarks, he spoke of the virtue of coating fireclay and potclay by specially refractory materials. In particular he mentioned the use of carborundum and of zirconia as being likely to yield results of a satisfactory nature.

Dr. P. G. H. Boswell spoke of the need of further investigation in the behaviour of potclays and hoped that glass manufacturers themselves would experiment. In addition, little was known as yet as to the effect of small amounts of impurities in potclay. For example, might not titanium oxide have a deleterious effect? He discussed the purification of clay on a large scale and also spoke of the future of surface combustion in glass manufacture.

Mr. Spiers, the secretary of the Faraday Society, appealed to glass manufacturers to make known their difficulties regarding refractories. The main object of the Faraday Society was to concentrate on these difficulties, and up to the present they had had considerable success.

The July meeting of the society will be held on Wednesday, the 25th inst., in Manchester. Papers will be read on the "Action of Various Solvents upon Glass."

THE CHRISTIANIA JUBILEE EXHIBITION, 1914.—The accounts of this exhibition show a deficit of 320,000 kroner, caused chiefly by a strike on the part of the tramway men in July and the breaking out of the war in August, which adverse circumstances are estimated to have reduced the receipts by some 400,000 kroner. The cost of the buildings was 1,700,000 kroner, against a calculated expenditure of 1,160,000 kroner. Under ordinary circumstances a small surplus would in all likelihood have been the result (18 kr. = £1).

"THE EXCAVATING ENGINEER."—We are informed that *The Excavating Engineer*, of Milwaukee, U.S.A., has temporarily suspended publication. Both the editor and his assistant have been called to the colours. They felt that the duty of every able-bodied man of military age was first towards his country, and that at this critical time the country could be served better in the field than by the publication of a technical journal, which by its continuance would keep men of military age and experience from the colours. They say that when their armies return victorious they will resume publication. It is clear that America is taking the war very seriously, even so far West as Milwaukee. It has often been suggested that enthusiasm for it is only to be found in the Eastern States, but this is clearly not correct. The excavating engineer will find plenty of scope for his knowledge at the front, and there is much that the American engineer can teach the Allies.

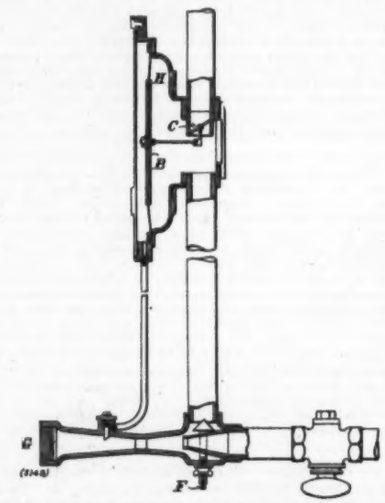
AT THE FRONT.—The safe arrival in British waters of an American fleet of destroyers, says *The Marine Journal*, New York, is an announcement of the fact that, after two years' vacillation since the Lusitania was sunk by a piratical German submarine, the United States is at the front in earnest, and will, it is believed, contribute its bit with the Allies toward the victory that must eventually end the war for the future benefit of mankind. Our destroyers, adds the American journal, now in touch with the British fleet which has bottled up the German Navy, are the best of the kind we have to offer, while Rear-Admiral Sims, in command, has studied the situation for some time, and is no doubt well informed as to the service expected of the Allies' most recent ally. It will be but a short time until the large American fleet of submarine chasers will join the initial fleet of destroyers; then, soon after, if not before, a large force of our regular troops will be facing the German-Austro-Hungarian army; after this there will be no cessation of hostilities until the German flag will float nowhere on the face of the globe but within the German border, which territory no nation, as far as we know, craves.

BRITISH TRADE WITH CANADA.—Sentiment favouring United Kingdom goods is undoubtedly an important factor in the Canadian market says *The Board of Trade Journal*. There will continue to exist, after the war, a strong antipathy to the merchandise of enemy countries, and their salesmen will meet with considerable difficulties in endeavouring to market goods. One hears somewhat frequently of buyers who, while expressing a desire not to trade with Germany and Austria after the war, express also some doubts as to whether they will not be obliged to purchase certain lines of enemy goods, other countries not being able to supply them even at slightly higher prices. This feeling suggests the desirability of all possible publicity being given to the lines which were formerly supplied by German manufacturers but are now being manufactured in the United Kingdom. Buyers in Canada should be kept informed, by the activities of Canadian branch organisations and salesmen, and by adequate advertising in Canadian papers and magazines, of the fact that no good reason exists for the purchase of goods of this or that kind from Germany and Austria, as British goods are available. Even should it not be possible at present, on account of war conditions, for an export trade to be carried on with Canada, there is a valuable opportunity now to pave the way for trade in United Kingdom goods which can replace German and Austrian goods by removing any doubts existing in Canada as to the ability of United Kingdom manufacturers to supply the market after the war. Should this work be left over until the conclusion of the war, the results are likely to prove far less valuable than if it is undertaken at once.

AUTOMATIC CONTROL APPARATUS FOR GAS FURNACES.

THE annexed illustration shows an automatic apparatus for controlling the mixture of gas and air to a gas furnace, brought out by the James Keith and Blackman Company, Limited, of 27, Farringdon-avenue, E.C. 4. It will be seen that the air inlet is at the right-hand of the lower pipe, and that the gas enters the injector by the vertical pipe, the mixing taking place in the injector. In the gas pipe is a butterfly valve C which is operated by the movements of the diaphragm B. The two sides of this diaphragm are subject to different and varying pressures. On the left it is connected by a pipe to the injector, as hown, and at the right it is subject to the gas pressure. The position of the gas valve is therefore controlled by the difference of pressure on the two sides of the diaphragm. The air nozzle, after adjustment, can be locked by the screw at F.

If there should be a decrease in the gas pressure there would result a corresponding decrease in the compression on the valve side of the diaphragm. The



velocity of the mixture through the injector would remain practically the same, since the air pressure would be unaltered, and, consequently, the compression on the left side of the diaphragm would be unchanged. To restore the balance between the two compressions the diaphragm must move towards the valve—the side of least resistance—thereby increasing the gas inlet by opening the butterfly valve, until a state of equilibrium is established by making the two opposing forces equal.

Now let us assume an increase in the air pressure. The mixture velocity would be increased, therefore the compression in the chamber also increased, and the diaphragm movement, to restore the balance, would again be towards the valve, resulting in the correct increase in the gas inlet.

Next let us consider the effect of an increase in the furnace resistance. This is equivalent to closing down, more or less, the mixture outlet, and would directly increase the pressure, but decrease the velocity of the mixture in the injector. As both the pressure and the velocity influence the compression behind the diaphragm, it would be their combined effects on the diaphragm that would make the necessary adjustment in the gas pressure to meet the decreased volume of air entering the injector. The air volume decrease is, of course, also consequent upon the higher resistance.

MINISTRY OF MUNITIONS ORDER.—With reference to the Order (see vol. cii, page 234) made by the Minister of Munitions on August 28, 1916, applying Regulation 30 A of the Defence of the Realm Regulations to war material consisting of machine tools and machinery driven by power and suitable for use in cutting, stamping or working metal, and to the general permit for purchasing or entering into negotiations for the purchase of the said war material issued by the Minister of Munitions on August 28, 1916, the Minister of Munitions hereby gives notice: (1) That he, as from the date of this notice (June 26) withdraws the said general permit except in so far as the same relates to the insurance of the said war material. (2) That all applications for a permit to purchase or enter into negotiations for the purchase of the said war material referred to in the above-mentioned Order should be made to the executive officers of the Area Clearing House Boards, whose addresses may be obtained upon application to the Director, Central Clearing House, Ministry of Munitions, Charing Cross Buildings, W.C. 2.

NITRATION OF TOLUENE.

THE investigation of the nitration of toluene conducted by Mr. E. J. Hoffman on behalf of the United States Bureau of Mines was undertaken with the special object of ascertaining whether there was any justification for the prevalent prejudice that toluene from water-gas was unsuitable for nitration, because it contained some hydrocarbon of the aliphatic series. Hoffman found that the impurities in his water-gas toluene did not amount to 1 per cent., and that the nitration proceeded as with ordinary toluene. His report (Technical Paper 146) is instructive as a review of the literature on the subject—the literature is brought up to date—and as an account of experiments of his own. Broadly speaking, toluene is still nitrated as it was by Wilbrand in 1863, with the aid of fuming nitric acid and sulphuric acid. That treatment yields mono, di- and trinitrotoluene, indicated by MNT, DNT and TNT. Of the mono-products three are possible, the α, β and λ; of the DNT six isomeric compounds can exist and are known; of the TNT six are again possible, but up to 1914 only three were known and distinguished as α, β, γ; since then the remaining three have been prepared by Koerner and Contardi. The chief explosive is the α TNT. Toluene is $C_6H_5.CH_3$, and if we imagine the CH_3 group to be at the first corner of the hexagon (or benzene ring), the three NO_2 groups occupy the α body, the corners 2, 4, 6. This most symmetrical α product melts at 80.6 deg. C., whilst the 3, 4, 6 nitro product (in which the NO_2 groups are crowded together opposite the CH_3 group) has the highest melting point of the six isomers, 137.5 deg. C.

Which of the possible M, D or TNT products will result when toluene or certain of its derivatives are treated with the acid mixture is essentially a question of acid temperature, proportion and concentration, and of time; mixtures of products are generally obtained. In the one-stage processes the reactions (1) directly yield TNT; in the two-stage processes either (2) DNT is first formed and further nitrated into TNT; or (3) MNT is first made, which is further nitrated into TNT; in the three-stage process (4) MNT, DNT and TNT are successively formed.

TNT is really a stable compound, and its preparation relatively safe, apart from the poisonous character of the products; it is insensitive to blows and burns rapidly without explosion, but can be detonated by fulminate. The relative safety of the TNT was one of the features entering into the final judgment given last winter by the Imperial German Court in a suit that had been pending for 10 years. A watchman noticed a fire in the mixing room of some Westphalian explosive works at 8 p.m.; at 8.45 a slight explosion took place; it was unimportant in itself, but set fire to a shed, 15 metres off, in which TNT and the nitrates of ammonium and potassium were stored; at 9 p.m. a big explosion followed. This explosion caused a fire in the factory of another firm, K; K claimed damages, lost his case in the lower court, but won on appeal, and in the highest court. The court found negligence in two instances; firstly, if proper supervision had been kept in the mixing room, which had been closed at 6 p.m., the fire would have been discovered before 8 p.m.; secondly, the storage of TNT in the same building together with nitrates constituted negligence, though none of the products alone was considered dangerous, and though the joint storage does not expressly appear to be forbidden.

ROYAL METEOROLOGICAL SOCIETY.

THE last monthly meeting of this society for the present session was held on Wednesday, the 20th inst., at the society's rooms, 70, Victoria-street, Westminster, Major H. G. Lyons, F.R.S., D.Sc., president, in the chair.

Mr. C. E. P. Brooks, M.Sc., F.R.Met.Soc., read a paper entitled "*The Reduction of Temperature Observations to Mean of 24 Hours, and the Elucidation of the Diurnal Variation in the Continent of Africa.*" Mean temperatures obtained from various combinations of observations should be reduced to true mean or mean of 24 hours to make them comparable. This is generally done by interpolation, but interpolation is not possible in Africa. An alternative method is given by representing the diurnal variation of temperature by means of the first two terms of a Fourier series:—$Th = a_0 + a_1 \sin (H + A_1) + a_2 \sin (2H + A_2)$. This gives six variables, and a_0 can be found if we have three observations a day and two of the constants; a_1 and a_2 can be calculated from mean maximum minus mean minimum, and the reductions of various combinations of hours to true mean is discussed on these principles, and the connection of the various constants with physical factors is also discussed.

Mr. F. J. W. Whipple, M.A., F.R.Met.Soc., read a paper on "*Autographic Records of the Air-wave from the East London Explosion, January 19, 1917.*" The records which were made use of in this investigation were of two kinds, those from ordinary barographs and those from the recorders used for indicating the pressure in gas-mains. The gas engineer measures the difference between the pressure in his mains and the pressure of the air, so that his instruments show sudden changes in air-pressure as well as the barographs and on a much more open scale. As a large number of records were available in the neighbourhood of London, it was possible to map in some detail the intensity of the air-wave from the East London explosion. A measurable disturbance was shown as far to the north-west as Enfield and as far south as Whyteleafe, but the range to the north-east was very restricted.

Mr. R. C. Mossman, F.R.Met.Soc., read a paper on "*Some Aspects of the Cold Period, December, 1916, to April, 1917,*" in the course of which he remarked that the mean temperature of the British Isles during the period under notice, taking the mean of the 12 divisions used in the monthly weather reports of the Meteorological Office, was 1.9 deg. C. below the normal, the extremes ranging from — 2.8 deg. C. at Belvoir Castle in Leicester and — 2.7 deg. at Newquay to — 0.5 deg. at Castle Bay in the Hebrides. The cold, except in December, was general over Western Europe, the mean temperature of Sweden being 1.9 deg., of Holland 2.7 deg., and of Norway 1.5 deg. below the average, whilst so far south as Gibraltar the mean was 1.1 deg. under the average. It was shown that when the eastern portions of the British Isles had a mean temperature below the normal in each month from December to April, an event that had only occurred on five occasions in the last century and a half, there was then a pronounced tendency for the depression of temperature to continue without interruption till the end of the year. The only exception occurred in 1808, when a warm period covering the four months, May to August, was sandwiched between two cold spells. The frequent absence of historic frosts during long periods of uniform cold over the British Isles was also referred to.

"THE ELECTRICAL PROPERTIES OF GASES."

TO THE EDITOR OF ENGINEERING.

SIR,—It matters not if one person wrote three letters each signed differently, or if two or more persons have put their heads together to compose one letter; but if "cranks" are not to be answered many of your readers besides myself will be deprived of information that would be welcome on the important questions raised in the correspondence which followed the publication of the very interesting series of articles published in ENGINEERING. I trust that further light may be thrown on the atomic structure of electricity, as to which so little is at present known.

Yours very truly,
W. HOWARD.

1, Ravensbourne Park, S.E., June 25, 1917.

TO THE EDITOR OF ENGINEERING.

SIR,—Granted that we cannot prove our existence; yet, for the sake of argument, let us assume that we do exist and not allow what promised to lead to a profitable discussion to degenerate into personalities.

Our great physicists may, at times, be too positive in their assertions. No one has demonstrated the fact, if it be one, that each chemical atom is a little universe comprising many suns and planets. The theory is helpful and stimulating; perhaps it is true; but its truth has not been established.

As one of your correspondents stated, if electricity is atomic, its ponderability might be demonstrated; and if charged particles can be made to breed, the exact meaning attached to the word "breed" ought to be determined.

Faithfully yours,
Hayes, June 25, 1917. A. W. S.

[Unless correspondents will define what they mean by "demonstrate," "prove" and "know," this correspondence cannot possibly lead to any useful conclusion. "A. W. S." asserts that it has not been "demonstrated that the chemical atom is a little universe." The obvious reply of "Didymus" will be that it has not been "demonstrated" that the chemical atom exists, and the net result is merely a waste of paper and printer's ink.—ED. E.]

FERRO-CONCRETE SHIPBUILDING IN GERMANY.—Some few months ago a small company, with a capital of only 100,000 marks, was formed in Hamburg for ferro-concrete shipbuilding, and the money was mostly found by persons interested in shipping. The system adopted is that of a Herr Rüdiger. The Imperial Dockyard in Kiel has placed with the company a couple of orders for a sea-going lighter of some 300 tons carrying capacity and a motor cargo-boat. The German Lloyd has thoroughly investigated drawings and calculations, and has stated its willingness to support this new type of shipbuilding. The Imperial Naval Department in Berlin has also examined the method, with encouraging results. The marine insurance companies have likewise expressed their willingness to insure the ferro-concrete vessels at fair rates. The company is about to build a motor ferro-concrete boat of some 600 tons, fitted with a 300-h.p. Diesel engine.

ASSESSMENT FOR INCOME-TAX—ALLOWANCE FOR DEPRECIATION OF DIESEL ENGINES.—After protracted negotiations an agreement has been concluded with the Inland Revenue Authorities to increase the rate of depreciation upon Diesel engines to 10 per cent. per annum, with the proviso that this increase shall remain in force for three years after cessation of the war, when either party shall be at liberty to claim a revision. The appeals have been in the hands of Mr. Arthur D. Bird (of Humphreys-Davies and Co., Limited) and Mr. Percy Still (hon. secretary of the Diesel Engine Users' Association). Having regard to the present high level of taxation, this increased allowance represents no inconsiderable saving to those companies and corporations entitled to the concession, and the Diesel Engine Users' Association is to be congratulated upon its enterprise in the matter. About two years ago the association took up the question of insurance of Diesel engines against breakdown, and was successful in bringing about a very substantial reduction in the premiums which had previously been charged in connection with that class of risk. The result of its activity in connection with income-tax assessment will now confer a further very important benefit on the firms and undertakings with which its members are connected.

WELDING WITH APPLICATION TO AUTOMOBILE ENGINEERING.*

By HERBERT L. TOWNS.

THE evolution of the methods employed by manufacturers in the industrial world is undoubtedly a source of wonder, and probably one of the greatest advances is that of welding. Along with welding has come the cutting of metals by the application of heat, and so great has been the development of these means of manufacture, that the welding and cutting apparatus has become an ideal and absolute necessity to the engineering trade.

In dealing with this subject it will be advisable to make some classification, and the best method to adopt will be to deal with the process of welding in a general sense, and then consider the possible applications to automobile industry.

Welding is the process of joining two pieces of metal by melting the adjacent edges of the metal together, and the methods of producing the necessary heat have varied; among them are the oxy-hydrogen, the oxy-acetylene, and the electric arc methods. The oxy-hydrogen flame is very rarely, if ever, used, as the heat produced by this flame is not nearly so intense as the heat produced by the oxy-acetylene flame or the electric arc, and as the oxy-acetylene flame is more extensively used, it will be as well to confine all consideration to this method in order to devote the limited time at our disposal to a single subject.

Oxy-acetylene welding is classed as an autogenous welding process in which two parts of the same metal, or different metals, are joined by the melting of the adjacent edges of the two parts and causing them to become joined without the use of hammers or any form of compression the melting of the edges of the pieces of metal being performed by the heat produced by an oxy-acetylene flame. It may be well to mention that the term "autogenous welding" is often used as being the method of welding performed by the heat of the flame produced by the combustion of a mixture of gases, but the correct meaning of "autogenous welding" is the joining of pieces of metal without the aid of any foreign material.

The oxy-acetylene flame is very small in size, and results from the combustion of a mixture of oxygen and acetylene, which mixture has been made in a special burning torch or blowpipe.

Acetylene.—Acetylene is a gas, and may be quoted approximately as 92½ per cent. of carbon and the balance hydrogen, this only being approximate on account of certain small percentages of impurities that may exist; for instance, a certain proportion of the hydrogen may be phosphuretted and sulphuretted.

The presence of hydrogen retards the combustion of carbon in oxygen, so in order to get a more rapid combustion, oxygen is mixed with acetylene, which mixture generates the hottest flame for welding, a heat of up to about 7,000 deg. F. being obtainable. This heat is greatly in excess of the heat produced by the oxy-hydrogen flame, the heat generated by the oxy-hydrogen flame being only about 4,000 deg. F.

Two important methods of supplying acetylene to a shop in which the welding of metals is performed are largely adopted, these being either to have portable welding outfits which include the generator, oxygen cylinder, flexible pipes, blowpipe, &c., or to have the generator fitted in a special shed or house built outside of the shop. In the case of the portable outfit each operator has one of these appliances, which can be moved to any part of the shop as required. It will be seen that this method is most useful in shops where welding is not too frequently required to be done. In the case of the fixed generator the whole supply of acetylene for the use in the shop can be produced and led into the shop through pipes, the size of the generator being arranged to suit the size and requirements of the shop.

Acetylene Generators.—There are various types and makes of generators now on the market, and it will be very interesting and I hope instructive to devote some attention to one or two of these types. A type of generator suitable for attaching to a portable welding plant is shown in Fig. 1. This generator is very compact, light in weight, and has the advantage of being adaptable to almost any portable framework, as it requires no fixing. Adjustable chains can be fitted to the side of the tank for the purpose of carrying the oxygen cylinder, in which case it is unnecessary for the generator to be fitted on a framework; it can stand on the floor and be moved from place to place as required. The following table shows the size of the generator in comparison with the output of acetylene.

TABLE I.

Height.	Weight.	Output of Acetylene per Hour.	Charge of Carbide.
ft. in.	cwt. qr. lb.	ft.	lb.
4 9½	3 2 0	50	20
6 6	4 1 14	70	30
7 3	4 3 0	100	50
7 9	6 2 0	150	75

Fig. 1. PORTABLE ACETYLENE GENERATING PLANT

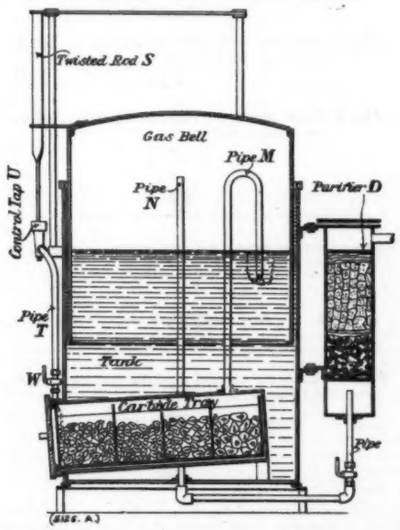
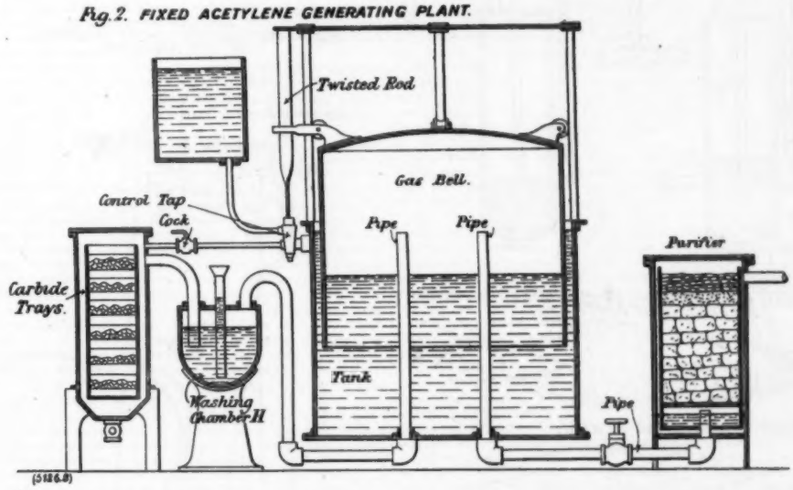


Fig. 2. FIXED ACETYLENE GENERATING PLANT.



A generator of this description is automatically controlled, and therefore requires little or no attention save the charging of the carbide tray and the filling of the water tank. It will be seen from Fig. 1 that the carbide chambers are actually contained in the water tank, which makes the generator very compact. The plant is worked as follows:—Carbide is placed in the carbide trays or generators (the sketch only shows one, but two are fitted side by side) and the tank is filled with water. The cock W which is fitted to the pipe T connecting the water tank with the generators is then opened, and water flows from the water tank to the generator; acetylene is then produced, and passed through the pipe M into the water, through which it bubbles into the gas bell; as the gas bell fills with acetylene it rises, being steadied by guide and pillars. One of the guides on the gas bell has an extension fitted, which engages with a twisted vertical bar S, this bar controlling the water cock U. Now, as the gas bell fills and rises the bar S is automatically operated to shut off the water cock U, this preventing further flow of water from the tank into the generator. The acetylene is taken from the gas bell through the pipe N and is passed through the purifier D to the burner. It should be noted that the acetylene is first purified by being passed through the water, from the pipe M into the gas bell. As the acetylene is used, the gas bell falls, and the cock U is again opened to allow water to pass into the generator, and the process repeats itself.

TABLE II.

Height.	Weight.	Output of Acetylene per Hour.	Charge of Carbide.
ft. in.	cwt. qr. lb.	ft.	lb.
6 8	13 2 0	100	36
6 8	16 3 0	140	50
6 8	19 0 0	160	60
9 3	22 2 0	175	75
9 3	27 0 0	250	100

A type of fixed generator is shown in Fig. 2, which type of plant does not differ in principle from that shown in Fig. 1. In this type of plant the generators and the purifying chambers are independent of the gasholder. It will be noticed that a special washing chamber H is provided through which the acetylene is passed from the generators to the gasholder.

The table in the preceding column shows a comparison of the size and output of these types of plant.

In each of these types of plant the generators can be recharged with carbide without in any way disturbing the supply of acetylene, as the gas cannot get back from the holder into the generators. These types of generating plants are manufactured as standard articles in various sizes by the Imperial Light Company.

A method of supplying acetylene to the welding torch, which is not commonly used in practice, is that of having the gas stored in tanks or cylinders, instead of generating it. The acetylene contained in these tanks or cylinders is dissolved in a liquid called acetone, this being the only known liquid that will dissolve acetylene to any appreciable extent. Acetone will dissolve 24 times its own bulk of acetylene at ordinary atmospheric pressure, and also possesses the strange feature of destroying the highly explosive nature of acetylene while they are mixed together. This feature has the extreme advantage of rendering cylinders of dissolved acetylene safe for handling and transporting, an advantage which is worth consideration. Acetylene is probably more useful in this form for purposes other than welding, for instance, the lighting of automobiles and ships, where generators would be a more dangerous fitment. Also there is the possibility of drawing the acetone out of the cylinder with the gas, if the rate of discharge of the gas becomes excessive, the result of this would be a reduction in heat of the flame.

Oxygen.—The oxygen which is used to support the rapid combustion of the acetylene is not as a rule manufactured by the consumer, and there is actually only one firm in this country at present which manufactures this gas in any appreciable quantities. The supply of oxygen is by no means adequate enough to meet the demand for industrial purposes, and some idea of the demand can be gathered from the fact that the British Oxygen Company alone, who are at present making additions to the oxygen-producing plant, hope when this is completed to have an output of approximately 375,000,000 cub. ft. per annum, or about 1,250,000 cub. ft. daily.

The pressure and consumption of oxygen is governed by the size of the blowpipe used to suit various thicknesses of metals, as will be seen from Table III.

TABLE III.

Thickness of Metals to be Welded.	Approximate Oxygen Pressure Required.	Approximate Consumption per Hour.	
		Oxygen.	Acetylene.
in.	lb.	cub. ft.	cub. ft.
1/32 to 1/16	5	2	1½
1/16 to 1/8	6 to 7	3½	3
1/8 to 1/4	7 to 8	8	6
1/4 to 1/2	13 to 14	14	11
½ to ¾	21 to 22	35	28
¾ to 1	27	55	42
1 to 1½	30	78	63
1½ to 1¾	37	100	80
1¾ to 2	40	125	100

Oxygen cylinders are made in sizes varying to contain from 10 to 200 cub. ft. of the gas, the size most commonly used being the 100 cub. ft. If the welder knows the actual or water capacity of the cylinder, he can determine the approximate volume of gas remaining in a cylinder. This information is very useful, and in reality essential, in the case where a welder has a partly spent oxygen cylinder and a somewhat lengthy piece of welding to do, in order that it may be ascertained if sufficient oxygen is available to complete the work. As an example the following may be taken. Say a piece of welding work is

* Paper (somewhat abbreviated) read before the Coventry Branch of the Institution of Automobile Engineers.

required on metal of ⅛ in. to ¼ in. thick, for a length of, say, 2 ft. This will necessitate the use of a blowpipe, which will consume 42 cub. ft. of acetylene per hour, and the work would require about half an hour in which to be completed, as will be seen from Tables III and IV. The consumption of oxygen for this work would be approximately 27½ cub. ft. Now if we assume that the welder has one 100 cub. ft. cylinder, which is indicating a pressure of 36 atmospheres, would it be possible to execute the work? The welder, knowing the actual or water capacity of 100 cub. ft. cylinder, say, 0.833 cub. ft., can easily estimate the possibilities of being able to complete the work with the use of this cylinder. Knowing the pressure of gas in the cylinder (36 atmospheres) and the capacity of the cylinder (0.833 cub.ft.) the volume of gas at his disposal is equal to $36 \times 0.833 = 30$ cub. ft. (approximately). If we deduct, say, 2 cub. ft. or 3 cub. ft. which remain in the cylinder when the pressure has fallen to about 2 atmospheres, and allow for the possibility of a slightly larger consumption of oxygen by the blowpipe, we are left with approximately 26 cub. ft. or 27 cub. ft. of oxygen, and it would probably be possible to finish the work if it were done rapidly.

Installation.—Having considered the production of the necessary gases for oxy-acetylene welding, the next point for consideration is the carrying of the gases to the place for burning. Where a fixed generator is used it is necessary to have fixed pipes for the service of the acetylene to the place (or places where more than one blowpipe is being served) of welding, and the gas fed to the blowpipe by a flexible tube connection from the service pipe. Just as the use of copper is prohibited in the manufacture of acetylene generators, the use of copper tubes is prohibited for serving the gas to the blowpipe; therefore iron pipes should be used for this purpose, and these should preferably be galvanised, as the presence of any moisture in the gas would tend to form iron oxide, which may leave the pipe and accumulate in some more vital part of the installation. These fixed pipes should be fitted to the wall of the shop, and should be arranged with a slight upward run, so that any moisture forming in the pipe would tend to run back to the generator.

The size of the pipes fitted depends entirely on the number and size of the blowpipes to be used, and this should receive careful consideration in arranging for the fitting of an oxy-acetylene welding installation in any establishment. There is a danger of the pipes being too small in size, which results in the acetylene arriving at the blowpipe in insufficient quantities and probably at a considerably reduced pressure, hence the welder may have to increase the pressure of the oxygen he is using, with more or less disastrous results, as will be seen later in the consideration of the proportions of the gas mixture. It should be remembered that the length of the piping should be taken into account, as well as the size of the blowpipes to be used, when fixing the diameter of the piping, in order that the loss of pressure of the acetylene may not be excessive.

There is an apparatus that is absolutely indispensable in the welding installation, this being the safety valve. As a matter of fact each blowpipe must have a safety valve which, in the case where a portable acetylene generator is used, is fitted to the generator, and where a fixed generator is used the valves are fitted to the fixed service pipes, in each case the acetylene passing through the valve, which is also connected to the blowpipe by flexible tubing. A type of safety valve is shown in Fig. 3, a description of which is as follows:—The apparatus consists of a chamber or tank A, which is fitted with a filling pipe D, by which the tank is partly filled with water, the level of the water being regulated by the drain cock E. The pipe B is connected to the acetylene service pipe, and an outlet pipe C, to which the flexible tube is connected, is provided.

The object of fitting this safety valve is to prevent any oxygen from getting into the acetylene pipes, as would happen in the case of the blowpipe becoming temporarily choked up due to the splashing of molten metal or other causes, if a device of this description were not fitted, as the oxygen is always fed at a greater pressure than the acetylene; hence this safety valve prevents the formation in the pipes of a mixture of the two gases, which would be of an explosible nature, and consequently dangerous in case of the flame back-firing.

The acetylene is passed from the service pipe into the water, through which it bubbles, and passes through the outlet pipe to the blowpipe. In case of a stoppage in the blowpipe the oxygen passes through the flexible tube into the tank A, and as the pressure in the tank is increased due to the oxygen not being able to gain an outlet, the water-level in the tank becomes lower, by the water passing into the filling pipe and the acetylene pipe, until the level of the opening into the filling pipe is reached, then the oxygen bubbles up through the water in the filling pipe and escapes into the air, as shown in Fig. 4. These valves require very little attention, save the checking of the water-level by the drain cock when the system is in use, this being preferable to getting the correct level under working pressure.

The feeding of the oxygen to the blowpipe is done through flexible tubing of three-ply rubber, which is preferable to metallic flexible tubing, owing to the increased danger arising from the deterioration of metallic tubing not being so noticeable as that of the rubber tubing.

Blowpipe.—The blowpipe is an instrument requiring careful consideration and thought from first to last, in the first place in the designing and lastly in the handling during operation—the consideration in design being partly to make the instrument absolutely safe in case of careless handling on the part of the welder, and consideration on the part of the welder partly to allow for bad design. The blowpipe, if properly designed, built up, and handled, is an instrument of simplicity and safety, being light, compact and easy to handle. The work to be performed by the blowpipe, namely, that of mixing the two gases, is of extreme importance, as the obtaining of a good sound weld to a great extend depends on the mixture of the gases.

In theory, for the total combustion of one volume of acetylene 2½ volumes of oxygen are required, but in actual practice the proportion of acetylene to oxygen varies between 1 to 1½ and 1 to 1¾. The result of a weld obtained by the use of a mixture of gases in incorrect proportions, may be of a very unsatisfactory nature, as if a superabundance of oxygen be admitted the flame produced will have oxidising effects, whereas if a superabundance of acetylene be introduced the flame produced will have a carbonising effect, in which case a hardening of the metal in the immediate vicinity of the weld will result, and the finished work will, consequently, be of a brittle nature.

The correct flame for welding is therefore half-way between an oxidising and a carbonising one. An experienced welder can readily estimate the proportions of the mixture of gases he is using by a glance at the flame produced. Some idea of the flames produced by different mixtures is given in Figs. 5, 6 and 7. Fig. 5 shows the flame produced by a mixture having an excess of acetylene, and all blowpipes should be able to produce such a flame by having the oxygen admitted at normal pressure and the acetylene at full pressure, although this flame should not be used. If a blowpipe is not capable of producing a flame of this description, either it is faulty, or the system for carrying the acetylene from the generator is in some way out of order, causing the passage of the acetylene to be obstructed. When a blowpipe is producing this type of flame the acetylene cock on it, or the outlet cock on the safety valve, should be partly closed, till a flame similar to that shown in Fig. 6 is produced, which is the correct flame to use. The centre white light which appears in Fig. 5, as a somewhat indefinite form has now become smaller and more definite. If a further reduction in the supply of acetylene be made by closing either of the cocks in the acetylene system already mentioned the centre white light becomes much smaller, as shown in Fig. 7, which is an oxidising flame, produced by a mixture of gases having an excess of oxygen.

There are many different forms of blowpipes in use, but the general principle is the same in each case, and they vary in length from about 1 ft. to 2 ft. The blowpipe as shown by the outline sketch, Fig. 8, consists of a handle through which pass two tubes, each fitted with a regulating cock. These tubes carry the gases to a mixing chamber, from which the mixture is passed to the nozzle. In the designing of a blowpipe an essential point for consideration is the distribution of weight, as the instrument should as nearly as possible balance when held by the operator, for ease of manipulation.

Blowpipes are divided into three distinct classes, which are named according to the pressure at which the acetylene is being used, namely: (1) low pressure, (2) medium pressure, (3) high pressure. The pressures at which the acetylene is used are approximately: (1) for low pressure, 0.1 to 0.25 lb. per square inch, which is the pressure at which the acetylene is generated; (2) for medium pressure, 1.5 lb. to 5.5 lb. per square inch; (3) for high pressure, 4.5 lb. to 7 lb. per square inch.

High-pressure blowpipes are not commonly used in practice, in consequence of which blowpipes are often referred to as being of two classes, high pressure and low pressure, the high-pressure class being what in reality is the medium-pressure class. The real high-pressure blowpipe is only adaptable in cases where dissolved or compressed acetylene is being used, all other forms of acetylene having insufficient pressure for the mixing of the gases. Low-pressure blowpipes are also uncommon as far as being used is concerned. In this type of blowpipe the gases flow at a very low speed, and back-firing is experienced however, safety devices are

Fig. 3. BACK PRESSURE SAFETY VALVE.

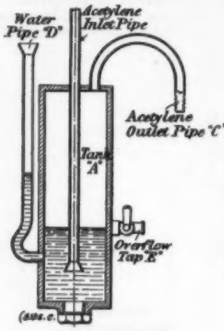


Fig. 4. BACK PRESSURE SAFETY VALVE SHOWING WATER UNDER PRESSURE OF A BACK PRESSURE.

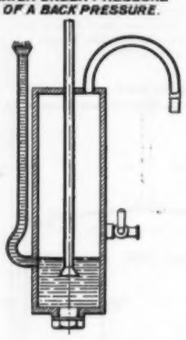


Fig. 5. FLAME PRODUCED BY A MIXTURE HAVING AN EXCESS OF ACETYLENE.

Fig. 6. NORMAL FLAME.

Fig. 7. FLAME PRODUCED BY A MIXTURE HAVING AN EXCESS OF OXYGEN.

Fig. 8. OUTLINE SKETCH OF BLOWPIPE

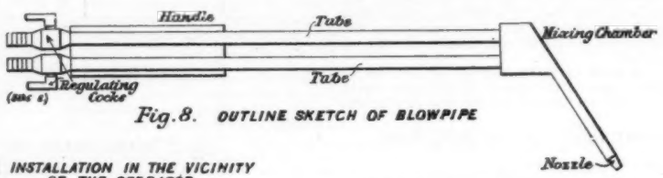


Fig. 9. INSTALLATION IN THE VICINITY OF THE OPERATOR

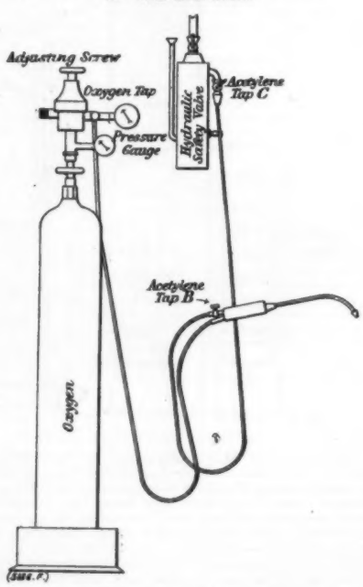
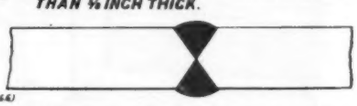


Fig. 10. FORM OF WELDS FOR METAL OF LESS THAN ⅛ INCH THICK.

Fig. 11. FORM OF WELDS FOR METAL OF, FROM ⅛ TO ⅜ INCH THICK.

Fig. 12. FORM OF WELDS FOR METAL OF, FROM ⅜ TO ½ INCH THICK.

Fig. 13. FORM OF WELDS FOR METAL OF MORE THAN ½ INCH THICK.



usually fitted, which render them safe to handle. The medium-pressure blowpipe is the type that is most commonly used, and has very few disadvantages. In this type of blowpipe back-firing is very unlikely, due to the pressure of the gases, which keeps the speed high.

The only real danger experienced in the use of the blowpipe is due to back-firing, and this is provided for by the fitting of safety devices. Attempts have been made to cut out this small piece of the installation, but the results have been far from satisfactory.

The blowpipe is usually made of brass, and is constructed in such a way that it is impossible for the gases to mix before they reach the welding head or mixing chamber. The nozzle is usually a detachable piece, so that the size of the orifice can be varied to suit the consumption of gases required for different classes of work. Blowpipes are usually supplied with a series of nozzles, which vary according to the consumption of the gases required for the different classes of work to be done. The size of the nozzle is determined by the consumption of acetylene per hour, and the sizes have a large range, being made to use acetylene at rates varying from 1 cub. ft. to 100 cub. ft. per hour. These nozzles are made of copper, which metal withstands the heat much better than other less suitable metals. The size of nozzle suitable for welding various thicknesses of metals may vary slightly according to the make of blowpipe used, but some idea of the consumption of acetylene can be gathered from Table III, and the approximate rate at which the various thicknesses of metals can be welded by using nozzles to give the consumptions shown therein is given in Table IV.

TABLE IV.

Thickness of Metals to be Welded.	Approximate Run per Hour.
In.	ft.
1/32 to 1/16	39
1/16 to 1/8	38
1/8 to 1/4	20
1/4 to 1/2	10
1/2 to 3/4	6
3/4 to 1	4
1 to 1 1/4	3
1 1/4 to 1 1/2	2
1 1/2 to 2	1

Some idea of the variation in costs of welding various thicknesses of metals can be gathered from Tables III and IV. To take a comparison, say 1 ft. of welding is to be done on a metal having a thickness of 1/16 in., and also a similar length on a similar metal having a thickness of 2 in. In the first case the consumption of oxygen and acetylene is 0.051 cub. ft. and 0.038 cub. ft. respectively, while in the second case the consumption of oxygen and acetylene is 125 cub. ft. and 100 cub. ft. respectively. Hence, the proportion for the costs of the gas alone is as 1 to 2500; on top of this the time taken for the operation is 39 times greater in the second case than in the first case.

It has already been mentioned that the blowpipe is an instrument of simplicity and easy to handle, but also being an instrument of precision, very great care is called for in its maintenance if a perfect and economical working is to be experienced. The cleaning of the nozzles should be attended to at regular intervals, and great care is required here, as the size and shape of the orifice should not be altered, because any change in this direction will cause more or less serious results when used again. Any increase in the size of the orifice of a nozzle would tend to decrease the velocity of the mixture at the exit, and the tendency to back-fire would be increased. It is therefore advisable in cleaning a nozzle to use some instrument which is not harder than the material of which the nozzle is made, and a suggested suitable instrument is a piece of brass wire, which should be run through the opening.

In order to ensure that the interior of the blowpipe is kept free from any obstruction, the blowpipe should be disconnected from the feeding tubes and the nozzles connected up to the oxygen tube, then the opening for feeding oxygen into the instrument should be temporarily closed, and a current of oxygen blown through the acetylene passage. By playing on the end of the acetylene passage with the finger a fluctuation in the exhaust of the oxygen is caused, and the clearing of the interior of the blowpipe is accomplished.

It is advisable to avoid the dismantling of a blowpipe by any except persons thoroughly experienced in this class of work, as the putting together of the parts requires a certain amount of skill, the accuracy of which governs the correct working of the instrument.

The starting up and stopping of the working of blowpipe should be done in a methodical manner, and the following are suggestions for doing this, references being made to Fig. 9, which shows an outline of the apparatus in the vicinity of the operator. First, the checking of the hydraulic safety valve for water-level should be done, by opening the overflow cock, and recharging with water if necessary, and the overflow cock closed. Now, with the lower acetylene tap B closed, the tap C should be opened, then the oxygen valve should be closed and the cylinder opened by means of the key. The adjusting screw should then be adjusted so the required working pressure is registered by the gauge. Now the tap B should be opened, and when the acetylene is smelt at the nozzle it should be ignited, then the oxygen tap should be opened to admit the oxygen to the blowpipe. It will be necessary to correct the oxygen pressure, which will have dropped, as will be seen by the gauge, due to the opening of the tap. Now by means of the tap B the acetylene should be shut down until the flame is normal as shown in Fig. 6. On stopping work the acetylene tap C should be closed first, then the oxygen tap D, and in case of work being completely stopped the oxygen cylinder should also be shut off and the pressure released from the regulator.

In case of a back-fire the tap C should be immediately shut off, and the blowpipe should not be relighted for a few seconds. Before the lighting up of the blowpipe, in the morning, it may be necessary to disconnect the acetylene pipe from the blowpipe, in order to drain out any accumulated moisture.

The Properties and Welding of Different Metals.—The use of welding instruments is a comparatively simple task which can be easily acquired by very short tuition or practice, but to become an expert welder is something much more difficult. In order to be able to execute welding in a manner worthy of the term welding it is necessary for the executant to have some knowledge of the properties of the metals which are to be welded. The knowledge of the properties of metals is useful in the preparation of parts to be welded, and it is often due to the lack of adequate preparation that comparatively simple operations in welding prove to be failures. The metals commonly used in the engineering industry are the only ones we need consider, these being: cast-iron, malleable iron, wrought iron, steels, copper, brass and aluminium.

Welding Rods.—Welding rods are used to replace any metal that has been taken away, either due to damage or due to preparation of the article to be welded. Welding rods should be used, except in cases where very thin metal, say less than 16 gauge, is being welded. Care should be taken in the use of welding rods that no impurities are introduced into the weld—for instance, the rods should be kept free from dirt or rust. Rods having rust on them are oxidised, and it has already been stated that an oxidised weld is not satisfactory. It is advisable to use welding rods supplied by firms who specialise in the manufacture of this class of goods.

In welding cast-iron work a welding rod of alloy iron should be used, known as silicated cast-iron rod. These rods have a fair percentage of silicon in them, which tends to take the brittleness out of a weld by reacting with the carbon in the iron.

In welding steels a rod of Swedish iron is almost invariably used, which, on account of its purity makes a weld of very even grain, and easily machinable. In cases where special classes of steels are being welded, such as "high carbon steel," "nickel steel," &c., rods of special composition should be used—for instance, in high carbon steel there is the possiblity of the carbon burning when the metal is being fused, and the welding rod should contain an excess of carbon in order to replace that which is burnt, so that the finished weld will be as nearly as possible similar to the metal being welded.

Rods of phosphor-copper are used for adding to welds made in copper, while for brass a rod of brass is used. In the case of these metals being welded in the form of sheets, the welding rod is really in the form of a wire. In welding aluminium a rod of aluminium should be used. These rods are specially alloyed, in order to give the necessary even flow of metal.

In all cases the welding rod should not be added until the metal being welded is melted, and for this reason the rods are alloyed to give them a lower melting-point than the metals being welded, so that the filling rods can be added without allowing the metal to cool down, for if molten metal comes in contact with cooler metal the result is simply an adhesion, and not a weld.

Fluxes.—Flux is used in welding as a cleansing agent, and is usually in the form of a powder. In the melting of metals it often happens that impurities will be left solid after the metal has reached fusing-point, also it often happens that oxides form which have a higher melting-point than the actual metal—for instance, in aluminium, as already mentioned, alumina forms, which has a melting-point much in excess of the melting-point of the aluminium (about 5,000 deg. F.). The purpose of using flux is to float off these impurities, or to produce a deoxidising effect which will retard the forming of oxides, and therefore keep the metals clean for welding together. These fluxes, like welding rods, form a speciality in manufacture, and include various mixtures. Samples of flux for iron and flux for copper and brass are here shown. Fluxes should not be used by spreading on the weld, but should be used by dipping the welding rods into them and transferring to the weld.

Preparation of Parts to be Welded.—It is important to make some preparation to the pieces to be welded, and in this there is a certain amount of scope for sound judgment on the part of the welder to make the most suitable preparation for the nature of the weld to be made. However, for straightforward work there are one or two points which apply generally. Plate work of a thickness of less than 1/16 in. can be welded with straight edges (Fig. 10); then for thicknesses between 1/16 in. and 1/8 in. the edges of the pieces should be bevelled slightly (Fig. 11). With plates or pieces of thicknesses between 1/8 in. and 1/2 in. the angle of the bevel should be increased (Fig. 12), and for thicknesses exceeding 1/2 in. the pieces should be double-bevelled (Fig. 13). In all cases the bevelled edges should be cleaned to remove any oxide that may exist. This bevelling is necessary so that the operator can reach the far side with the flame and welding rod, as in cases where attempts have been made to weld pieces of metal of a reasonable thickness without first bevelling the edges the metal has melted throughout the whole thickness at the same time, and the small white flame has swept the molten metal away on the near side, thus spoiling the weld.

Incidentally it may be worth mentioning here that the small white portion of the flame should never come into contact with the metal.

Preheating.—One of the sources of trouble in welding is the liability to develop cracks, which result in a broken weld, but this liability can be greatly reduced by the practice of preheating. In the welding of metal it is necessary to raise the temperature of the metal from that of the surrounding air to the melting-point of the metal, and one of the advantages of preheating is that whole piece of metal to be welded can be expanded, so that after the weld has been made a uniform contraction will take place, and prevent breakage of the weld. It is not the expanding of the metal that is the cause of damage so much as the contracting, for a weld may appear to be good and satisfactory after completion, but unless some allowance has been made for the contraction a break is more likely than not to occur.

Applications to Automobile Engineering.—Welding is not a practice that is adopted to any great extent in the production of automobile parts. One of the outstanding features of welded parts is the fact that comparative lightness can be obtained, where the part is not subject to much stress, by the use of thin metal. This fact should be taken advantage of in the manufacture of light cars as much as ever possible. Of course without considering light car design it is impossible definitely to state which parts should be built up and welded. In general automobile practice the extreme lightness which is characteristic of the light car is not required, hence, the practice of welding is not adopted to so great an extent as would be done in case of necessity; however, cases of necessity do occur.

Rear axles can be built up of steel tubes, with a central bronze casting, by welding, this being the only method of making a sound permanent joint. Parts such as water pipes should be built up by welding, all flanges being welded to the pipes, and branch pipes welded to the main pipe. Flanges can be welded to exhaust pipes, and silencers can be completely built up by welding, but this is not altogether practicable, on account of the difficulty of dismantling if it becomes necessary for cleaning inside. Brackets of various description can be built up by welding, but where thin metal is required pressings become a reasonable competitive proposition; however, where different thicknesses are required on a part pressings are impossible for the complete part. Radiators made up of pressings welded together are quite a commercial proposition, especially for commercial vehicle work, and can be turned out in quantities quite easily by an intelligent operator. For touring car work cast radiator tanks and brackets are preferable on account of a better appearance being obtainable.

In the experimental department of an automobile manufacturing works welding can be applied with some advantage, for the cost of patterns for castings might be eliminated to a great extent. Alterations to the compression of an engine can be carried out by cutting the connecting rod and welding up to make it either longer or shorter as required. Lugs or bosses can be welded to castings or other existing parts; in fact the practical use of welding in the experimental department is almost unlimited.

In foundry work the practice of welding is also applicable, as in the trimming of castings slight breakage frequently occurs, and repair by welding is preferable to scrapping the casting.

Repair Work.—Breakages are more or less frequent in almost every detail used in the construction of automobile work, and previous to the adoption of oxy-acetylene welding for the repair of such breakages the parts had to be replaced at some considerable expense to the owner. Now that the art of repair to breakages has become a satisfactory proposition, the parts thrown over to the scrap heap by the automobile owner are less numerous. However, to the automobile manufacturer, the carrying out of repairs is a much more satisfactory proposition by replacement than by patching up the existing part, as regards both finance and labour, except in cases where the part is of ancient design and some difficulty would be experienced in getting a single part through the works.

A common breakage in cylinders is in the water jacket, often caused by the freezing of the water, and such breakages can be repaired satisfactorily by welding. One point worth noting is that all damaged metal should be cut away in order to make a clean surface for welding.

Base chambers and gear cases are among the parts requiring careful handling and preparation in repair work, the main difficulty in these parts being the liability for error in the alignment of the bearing. However, by careful preparation in the way of adjusting the broken parts and preheating, this difficulty should be overcome. Where the metal is damaged the damaged parts should be cut away and a new piece welded in. No satisfactory result can be obtained by pouring molten metal into a crevice, as adhesion takes place instead of the new and old metals becoming joined as one piece, with the result that when the new metal cools down, cracks are almost certain to appear. Parts such as base chambers and gear cases are mostly made in aluminium, and in repairing aluminium the work should invariably be preheated to about 600 deg. F.

Breakages in frames can be satisfactorily repaired by welding, but as a rule it is advisable to back up the portion of the frame in the vicinity of the repair with a plate, because a breakage in a frame is a sign of weakness due more often than not to unfair distribution of the load on the part of the owner or owner's representatives.

Teeth can be welded to broken gear wheels, but this work should be carefully adjusted and clamped, then preheated before actually welding. The tooth or teeth to be welded in should be positioned by a plate, having slots cut in at the correct pitch of the teeth, so that the plate fits to portions of each of the two pieces to be welded together.

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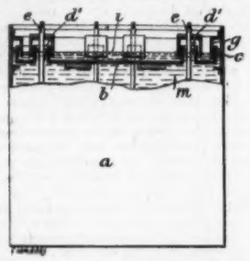
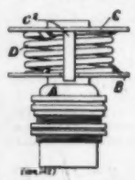
ELECTRICAL APPARATUS.

104,020. A. F. Berry, Ealing. Oil-Cooled Electric Transformers. (4 *Figs.*) February 16, 1916.—This invention relates to oil-cooled transformers. According to this invention, the oil container is provided with a cover or closure adapted to move with expansion and contraction of the oil, and at all times exclude contact between the external atmosphere and the oil in the casing by the aid of means in part carried by or connected to the cover or closure and in part carried by or connected to the casing. *a* is the oil-containing casing enclosing an electric transformer. *b* is a float constituting a vertically movable cover for such casing. The float has a flat upper surface, an upturned outer flange *c*, and four upwardly-extending flanges *d* surrounding



apertures d^1 to permit the primary and secondary terminal conductors *e*, in the form of rods, to pass freely through. A downwardly-flanged ring *g* is detachably connected in an airtight manner to the inner side of the casing *a* so that it depends over the outer flange *c*. The flanged apertures d^1 are individually covered by caps upon the respective terminal rods *e*. The float contains a layer of oil *i* for sealing the passages between the upwardly-flanged portions of the float and the casing and terminal rods. This layer of oil is completely out of contact with the oil *m* in the casing, so that in each case contact between the external atmosphere and the oil in the casing, including that between the casing and the float, is entirely prevented. (*Sealed.*)

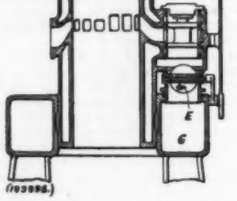
104,142. The Benjamin Electric, Limited, London, and E. Fowler, Slough. Electric Lamps. (3 *Figs.*) November 9, 1916.—This invention relates to means for supporting electric lamps of the filament type, and to that type of support in which a spring or springs are employed to absorb or neutralise the effect of shocks or vibration. In the past a number of constructions of lamp supports, in which springs have been used, have been designed for this purpose, and the present invention consists in providing that type of lamp, having two parts between which the spring member is arranged, and which, for convenience, will be called the fixed plate or member and the lamp plate or member, with inter-engaging members or parts whereby undue torsional strain on the spring is prevented. A represents a lamp-holder, to the upper end of which is secured



a plate B having a central aperture. A second plate C, which is similar to the plate B, is provided having a central screw-threaded aperture for attachment to a tube, bracket or other support. Between these two plates B and C is arranged a compressible spiral spring D, its ends being conveniently secured to the plates B, C, respectively, as by clips or lips, punched out of the material of the plates B, C respectively. Thus when the device is secured in position by attachment of the plate C to the tube or other support, the lamp will hang suspended from the spring D, and any shock or vibration imparted to the plate C will be taken up by the spring D. In order that the spring shall not be subjected to torsional strain, according to the present invention, means are provided whereby the lamp member, which may be in the form of a plate, disc or cup, is prevented from being rotated beyond a slight distance relatively to the fixed member. In the example illustrated this is effected by means of pins or rods c^2 secured to one or other of the plates B or C. These pins, at their free ends, project through holes formed in either plate B or C respectively, the holes or cut-outs being of sufficient size to provide an adequate space around the pins c^2, so that normally, when the tube or bracket carrying the lamp is subjected to a shock or vibration, it will not be transmitted through the pins c^2 to the plate B. (*Sealed.*)

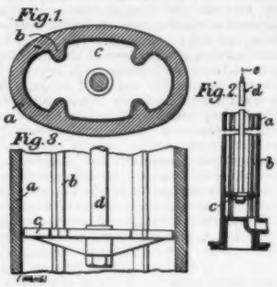
GAS ENGINES, PRODUCERS, HOLDERS, &c.

103,896. Scotts' Shipbuilding and Engineering Company, Limited, and J. Richardson, Greenock. Internal Combustion Engines.—(2 *Figs.*) March 15, 1916.—This invention relates to two-stroke cycle internal combustion engines of the type in which the heat of compression serves partially or totally to ignite the fuel injected at or about the inner or upper dead centre position. In the operation of internal combustion engines of the two-stroke cycle type the exhaust gases are positively expelled from the working cylinder by air under moderate pressure (scavenging air) which is discharged by a pump driven off the engine and which serves to charge the working cylinder with the air necessary for combustion in the next working stroke. Now, the primary object of the present invention is to adapt such an engine to run on fuel after a shorter period of preliminary running from an external source of energy (*e.g.*, actuation by compressed air or by an electric motor), so that a less number of preliminary revolutions will be required; a further object is to render such an engine capable of continuous running at slower speeds, with reduced liability to stoppage on account of failure to reach the necessary compression temperature and pressure. According to the invention, means are provided for ensuring that at the time of starting or in cases of slow running the scavenging air shall be admitted only to the cylinder or cylinders into which fuel will first be injected, so that, as a multiple of the normal quantity of scavenging air will enter such cylinder or cylinders, the scavenging air pressure will be higher and, the pressure at which compression starts being higher, the final compression temperature and pressure will be in excess of normal for the given speed, and hence the conditions will be



such as to ensure ignition of the injected fuel and to permit the engine to run on fuel. For slow running, provision is made for cutting off the fuel supply from a proportion of the total number of working cylinders and for admitting the entire available volume of scavenging air to the remaining cylinders, so that the compression pressure reached at the slow speed desired may be sufficient to ensure ignition of the fuel and thereby to permit the engine to continue to run on fuel. E denotes a throttle valve fitted in the pipe which connects the scavenging air reservoir with the cylinder. The throttle-valve spindle is connected with a hand lever L. In a six-cylinder engine three cylinders (the first, second and third of the set) are equipped with throttle valves and levers, as shown. Normally the throttle valves E are open. On starting up the engine, immediately the engine has reached the requisite number of revolutions when actuated from an external source of energy the throttle valves E are shut, so that all the scavenging air discharged by the pump driven off the engine is delivered to the fourth, fifth and sixth cylinders. Fuel is then admitted to the fourth, fifth and sixth cylinders. The extra compression pressure obtained in such cylinders due to the super-normal supply of scavenging air suffices to cause ignition of the fuel, so that the engine runs with three cylinders on fuel. When the number of revolutions has increased the throttle valves E are opened and fuel admitted to the first, second and third cylinders, so that the engines run with all six cylinders on fuel. If it be desired to run the engines for any considerable period at reduced power the supply of fuel to the first, second and third cylinders is cut off and the valve E shut. The engine then runs with three cylinders on fuel. (*Sealed.*)

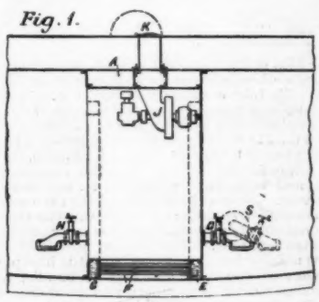
104,115. R. and J. Dempster, Limited, and R. Dempster, Manchester. Retorts. (8 *Figs.*) August 12, 1916.—The invention relates to retorts wherein spathic or sparry iron ore is alternately operated upon by reducing gases and steam for the production of hydrogen. The walls of the retorts *a* are provided with internal projections *b*, extending throughout the whole length of each retort, and means, according to this invention, are provided for preventing the undesirable breaking up of the ore into small fragments during charging operations. The means adopted, according to this invention, for preventing undue breaking up of the ore during charging operations take the form of a movable platform or plate C upon which the ore rests. This plate C is perforated or of open formation. In Figs. 2 and 3 the plate *c* is mounted upon a shaft *d* passing upwards within the retort. Such shaft *d* may pass through the ordinary plate or door at the top of the retort (not shown), or may be supported from the side walls of the retort by means of a cross-bar attached near the top end of the retort, and during filling operations be connected to a chain or connect on indicated at *e* in Fig. 2, or to the blocks provided for lifting the retorts themselves, which chain

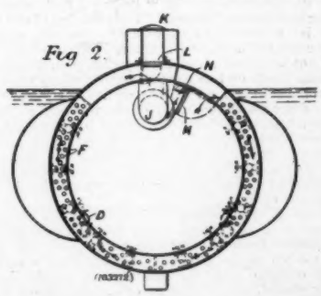


may pass over a wheel operated to raise the shaft *d* and with it the bottom plate *c*. In operation, and when the retort requires to be charged, the plate *c* is raised to an elevated position, so that on the ore being shovelled into the retort the first quantity of the same has only a small distance to fall on to the perforated plate *c*. The said plate may be lowered successive distances as the filling-in process proceeds, thus resulting in the ore having to fall a small distance throughout the charging operation, and with the result named. Projections *b* act as guides for the plate *c*. (*Sealed.*)

SHIPS AND NAUTICAL APPLIANCES.

103,272. H. E. Yarrow, Scotstoun. Submarines. (4 *Figs.*) September 1, 1916.—According to the present invention, in a submarine or submersible ship air is caused to circulate through a chamber of approximately tubular form extending over, or nearly over, a transverse section of the ship, in which chamber are disposed tubes or coils traversed by sea water or other cooling medium, and the air thus cooled is led to the parts of the ships as may be required. The sea water or other cooling medium may be caused to circulate through the tubes by mechanical means, or by the movement of the ship, or by the natural circulation due to convection; in the latter cases a special distribution of the tubes would facilitate the circulation. A is a tubular chamber extending round the inside of the hull of a submarine vessel, provided, in the example shown, with





external ballast tanks. D and H are respectively inlet and outlet valves for the sea water to and from the parts E and G of the chamber A, which are in connection with the tubes F, through which the cooling water circulates. S is a pump, which may be provided for the circulation of the water. J is a fan adapted to draw air through the door or scuttle K when the ship is on the surface, or through the chamber A when the vessel is submerged. This fan may be used to provide forced draught to the boilers. The air doors L and M are shown by full lines in the positions for circulating air through the cooling chamber A, the cooled air being conveyed through the trunk N to the stokehold or other parts of the vessel, as required. The path of the air is indicated by arrows. In the dotted positions of the doors L and M the air supply to the fan J is through the door K. (*Sealed.*)

THE END OF THE ONE HUNDRED AND THIRD VOLUME.